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HAND MADE GLASSWARE AND RECIPROCAL TREATIES

Since 1935, the American hand made glassware industry has been the football of foreign trade agreements, having been through the throes of tariff-tinkering five times in as many years. The practical effect of the Hull policy upon this entire industry and upon the fortunes of its thousands of workers is set forth in this narrative.

Bedeviled for the past two years by importations of foreign made glassware, which have been pouring into the country as a consequence of Reciprocal Trade Agreements, the flat glass and hand made glass industries are at last gleaning encouragement from the increasing political opposition that is developing in Washington toward the whole policy of the State Department. The authority delegated to the Secretary of State to negotiate trade agreements will expire on June 12. And though administration forces are striving to have the authority renewed, a large body of Agriculture, Labor and Industry are aligned in opposition.

Whatever may be said in praise of the Hull treaties—and Mr. Hull deserves only praise for his courageous and conscientious efforts to solve a most baffling problem—the timing certainly is wrong so far as Europe is concerned. With the whole of the European continent an armed camp, each of those nations today is motivated mainly by the urge of self-preservation. Their manufacturing facilities are mobilized less for commerce than for producing defensive armament. Foreign policy is formulated not to promote commerce, but mainly to placate warlike neighbors. Economic welfare is secondary to the necessity for survival.

Few nations, therefore, are in a position at this time to develop an export or import policy, to fulfill treaty obligations, to reciprocate with the United States. England only recently embargoed certain imports so as to conserve her foreign exchange to purchase vital necessities. Moreover, there are no ships to move this commerce backward and forward across the oceans, nor is there safety on the sea for those ships.

Turning to this side of the Atlantic, we find in the United States a condition of widespread unemployment, which it is the purpose of the Reciprocal Trade Agreements to alleviate by revitalizing industry. The operation of the plan, whatever Mr. Hull may believe to the contrary notwithstanding, requires that the United States desist from the manufacture of some particular merchandise and voluntarily surrender the business to some nation better adapted economically to produce it. The other nation covenants to reciprocate in kind.

Ipso facto, this plan contemplates that there will be a readjustment of our industries, and hence some inevitable dislocation. However, to attempt this at a time when American economy is precariously balanced between possible recovery and impending recession, seems not the part of statesmanship or wisdom. That this dislocation and readjustment can develop easily into something worse—absolute disintegration, can be demonstrated by the example of the American glassware industry, where many hundreds of workers have suffered needless privation and impoverishment; needless, because it has accomplished nothing.

At least, that is how the hand made glassware industry sees the picture. It will be the purpose of the present discussion to explore the experiences of the hand made glass industry during 1938 and 1939 and see what its labor and its capital have suffered that makes them so bitter against Reciprocal Trade Agreements.

By definition, hand made glass is essentially the product of hand labor. In the United States, 60 per cent of every sales dollar is returned to the worker as wages. The average hourly wage rate is 65 cents, and the work week is 40 hours. In Europe, the wage scale is 16 cents, and the work week 48 hours. In Japan, a skilled worker is paid seven to eight cents an hour.

To offset this discrepancy in wages, the American worker is protected by a tariff. Since 1930 this tariff or import duty has been maintained at 60 per cent ad valorem. Because of this protection, 40 factories have been able to give steady employment to some 13,000 workers —8,000 in the hand blown and 5,000 in the hand pressed trades. The pay envelope of skilled workers, according to government figures, contained $45 on an average, during 1937; other workers received about $25. In that same year, these 13,000 men and women, many only working only part time, produced $7,280,492 worth of blown ware and $6,096,073 of pressed ware. There are no figures to give even an inkling of how many million dollars in invested capital the 40 factories represented.

This was the statistical picture presented by the industry in 1937. That the sledding was hard even under a 60 per cent tariff, was described in the recent testimony of Mr. C. B. Roe, Chairman of the Governing Board of the American Glassware Association, who on January 24, 1940 testified before the Ways and Means Committee of the House of Representatives:

"Before the Czechoslovakian Agreement [April 1938], foreign glassware was selling at prices in this market which our manufacturers found it very difficult to meet—so difficult, in fact, that from the fall of 1937 to the spring of 1938, two large factories producing this ware and employing about 1000 persons, were forced out of business, and another large manufacturer reduced his personnel from 700 people, including skilled and unskilled, to 150."

But the worst was yet to come. On April 17, 1938 the Trade Agreement with Czechoslovakia became effective.

Upper 10 Glass Co. at Fairmount, with a view of the tank and blowing room.

The blowing room at Pennsboro Glass Company.

(Left) Clarence Brachler, sales manager at Pennsboro.

(Right) Tony Yaeger, another Pennsboro executive.

This reduced the duty from 60 to 50 per cent ad valorem; which, incidentally, is a drop of 16⅔ per cent. Everyone who patronized our retail stores at that time will recall that hardly an item of stemware or tableware but had its little sticker denoting the country of origin "made in Czechoslovakia"; or, because the same reduction in duty was extended automatically to all the other glass producing countries except Germany, "made in Belgium," "made in Japan."

The reason there was no American glassware of any consequence in these stores was that the American product had been selling at a level of about $1.75 the dozen, whereas under the reduced import duty the Czech counterpart could be sold at $1.40 or less, a difference of 20 per cent. Domestic producers couldn't possibly cut their prices 20 per cent—they were paying 60 per cent of the sales price alone to unionized labor.

The result was that the American factories did not get any business. They had to lay off their men. One large producer cut down the number of its shops* from 75 to seven, and then put these seven on part time. The same thing happened everywhere. Factories took just enough business, regardless of price, to keep a skeleton organization intact and to maintain their trade contacts. The balance sheet of any one of the 40 companies, red as a communistic flag, gives mute testimony of what it cost them to hang on and keep going.

But in every industry there are low-cost, marginal plants, and the hand made glassware industry is no exception. These marginal companies tried to meet the Czech prices—only to find that $1.40 was far from being rock bottom. The European glass industries are controlled by cartels or trusts. These cartels, with government sanction, establish the selling prices and incidentally the wage scales. So the marginal producers were out at the plate before even they went to bat, and all they succeeded in doing was to shove prices down still further. Since the marginals couldn't get any business, they too laid off their workers. Many classed as gain-

*A shop is usually about 6 men, depending upon the type of ware.

Pennsboro, formerly an abandoned win glass plant, was formed in 1938. Many of present owners are old Louie and Morgant men. Fifteen stockholders each put in $ worked $200.

fully employed, worked only a single move, and then for a couple of days a week.**

The Rise of the Cooperatives

Now there exists a belt of glass factories that starts at Cumberland, Md., runs westward to St. Marys, and takes in some 50 miles of territory to the north and south. Most of the glass blowers in these communities have worked in the different factories, which lie within easy traveling distance, and they know each other or about each other. As these factories kept laying off their workers and as unemployment grew, it was natural that these men of the same trade would meet, pass the time of day, or kill an evening in mutual commiseration. In the course of time, someone conceived the idea that they should band together and set up their own glass plant on a cooperative basis. With little to lose, the venture would be successful if they could make only wages. Wages they must have, or go hungry.

The idea took hold at Cumberland, Md., where a cooperative plant was quickly established. Then it spread to Ellenboro, across the line in West Virginia. Cumberland then organized a second company, and within a year there were nine in existence at St. Mary's, Pennsboro, Rochester, Jane Lew, Morgantown and Fairmount. These last named, in the order of their origin, were all West Virginia factories except the one at Rochester, Pennsylvania.

The creation of these cooperative factories is a tribute to the dauntless spirit and resourcefulness of men who refused to be conquered by circumstances. With a pioneer courage reminiscent of this nation's younger days, these glassmen hewed their own path to accomplishment. Where no one else could employ them, they devised means so that they could employ themselves.

The first need was capital. The unemployed, who have been out of work for many months, seldom have

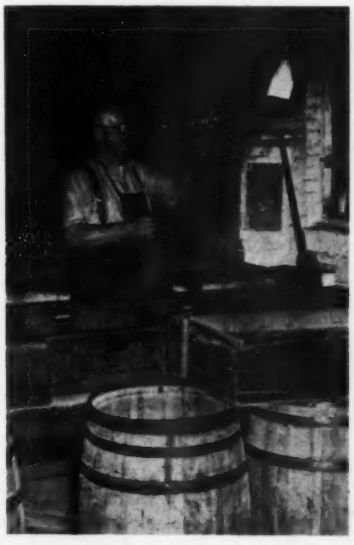
**A representative of THE GLASS INDUSTRY talked with one man who reported having worked a total of 18 days over a six month period. While probably an extreme, it is believed there were many who fared no better.

Upper 10 was the last of this group of cooperatives to organize. It got its first business by sending a letter to the trade offering to undersell any price by 10 per cent.

C. W. Yergan, treasurer and secretary; R. J. Schauwecher, president and general manager; Frank Gaglain, vice president of Cumberland. An old glass town, disastrous fires and depression ruined the glass business, Yergan and Gaglain, partners in the Queens cutting shop, organized Cumberland Glass Co.

Blower at work in Cumberland. This factory tried from the beginning to maintain its prices, but had difficulty since new competitors have come into the field.

rgantown was once one of the largest fac-es in this industry. Imported glassware pelled it to shut its doors in October 1937. ph Hayden, factory superintendent, organ- the Morgantown Glassware Guild, which perating the plant today with great success.



Mr. Gridley, inspecting glass at Cumberland. This was the first cooperative to be organized.

Three and a half ton day tank at Mid-Atlantic with the fires down.

Mid-Atlantic, one of the early cooperatives, was organized in 1936. Most of the workers are from the Louie factory. It did well at the start, but is having a struggle meeting competition, even with 18 cent gas.

Loy Casto, President (left) and Lloyd Games, sales manager, of Mid-Atlantic.

ready cash; so they slapped a mortgage on the home, borrowed a few dollars on a small life insurance policy, sold anything that would realize money. They went to the business men of their community, and though trade is not brisk and profits are meagre in a small mountain town, the business men helped all they could. Those who had no means of raising capital agreed to work out their stock by donating their labor.

The next need was a building. Scouting unearthed an abandoned building, an old garage; anything would serve. Owners gave it to them rent free for a period, or deferred the rent, or made the rent contingent upon sales. A deal was made with the tax collector. Old tools could always be picked up in a glass making community. And gradually the company became a going concern.

The cooperators were glass blowers, not salesmen. They soon found it was one kind of a problem to make glass, and quite a different problem to sell it. However, most of them remembered names of their former employer's customers, and thither they went for their first business. By that time, of course, the Czech glass was making the market, and the one chance the cooperatives had of getting an order was to undersell the foreign glass made with 16 cent labor.

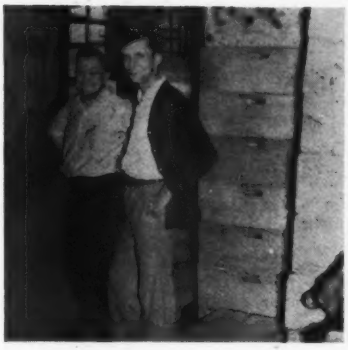
Only the fact that they were cooperatives enabled them to meet these low prices. Because they were owners of their businesses, they were exempt from the minimum wage laws. But they were union men; how keep their union cards? They met this problem by a simple subterfuge. They charged their labor on the books at union rates, but paid themselves only what the company could afford. The unpaid balance was carried on the books as an indebtedness of the company to be paid the worker if and when. And so, by working for $18 to $20 a week, by having little if any fixed expense, the cooperatives "got the business." Of course, as each new cooperative came into being, the newcomer broadened the spread of this sub-marginal price structure, anl soon there was a new spiral of downward prices that left behind even the Czech glass. But remember, these men were hungry!

To such straits had the American hand made glass industry passed, as the result of the Czechoslovakian

Two views of the blowing room at Allegany Glass Company, Cumberland, Maryland.

Lewis County, and outstandingly successful co-operation. Under the guidance of Mr. Yuchtman (see below) the company did a $120,000 business and paid back its entire indebtedness. The plant works two shifts.

Lewis County. Glassware coming off the lehr (right) for the packing table (left).



(left) Robert A. Yuchtman, president and sales manager of Lewis County. He organized the cooperative, mainly from Louie workers, and built a 17 ton tank that is a honey.

The Sloan Brothers, D. C. Sloan (right) is manager of Allegany and sales agent for the cutting shops of Sloan Glass and Kortright, Nehring and Weaver. A. Sloan (left) heads Sloan Glass.

J. K. Kizinski, vice president of Paramount Glass Co. This factory still retains and actually pays union wages, but as the picture shows, the factory is not very active at present.

trade treaty! Four thousand glass blowers and cutters and 1500 hand pressers were out of work. The other 7500 that were classed as gainfully occupied, got only two or three days work a week, which is not enough to feed and cloth a family.

In March of 1939, Germany overran Czechoslovakia. A month later, on April 22, the President by proclamation suspended the Czech treaty. And back went the tariff to its original 60 per cent level. There being no Czechoslovakia, there were no Czech importations. This trade was taken over mostly by Belgium, and then by other European countries. Japan was too busy in China to be much of a factor.

With the tariff back to its former level, one would imagine that prices would climb back as well. But they didn't. And here we uncover another result of the Trade Agreement program and one that isn't written down in the rule book. It has been demonstrated time and again throughout all selling that the existence of even a very small price cutting element will unsettle an entire industry. And without a bottom, a market cannot have a top. The cooperatives held down the bottom of the glassware market and the top had to stay down with it. The cooperatives, one must remember, had no selling experience; they were glass blowers. They could not even claim that their ware was technically correct; indeed, they had no technical control. Moreover, they had to sell in order to eat. No one can stand firmly by his prices, when the alternative is the bread line.

The buyers were quick to see in the cooperatives a set-up made to their special order and they did not hesitate to take advantage of it. Their cars wore ruts in the road leading Westward from Cumberland. They would dangle an order before the cooperative plant manager, and the story was ever the same: "If you won't take it at the price, the X company will." And the buyer was telling the truth; X company would have taken the order, gladly.*

The following experience is related by one who vouches that it was actually told him by one of the cooperative managers. A buyer called upon this plant

*A GLASS INDUSTRY investigator found one cooperative which boasts of its low prices. "Yes, we're the price cutters. We started it all," the manager announced with pride.

one day, and the conversation went something like this:

Buyer: Got any glassware to sell?

Co-Op: Plenty. How much do you want?

Buyer: 15,000 dozen of this item. What's your price?

Co-Op: Would seventy-five cents *be too much.*

The ware would have been a sacrifice at 80 cents and the buyer had come prepared to pay 80 cents. But could he be blamed entirely for closing at 75?**

We come now to the final act of the drama. Prior to the entry of the cooperatives, another and different group had been known as the marginal plants. As the year 1938 grew older, and as factory after factory gave up its business to the foreign glass companies, the pressure on the marginals became stronger and stronger. They cut and trimmed expenses; then they cut down their forces and, finally, like the rest, they had to operate intermittently, only a few days each week. Lacking the resources of the better financed companies, they reached the end of their tether more quickly, and they soon were faced with the alternatives of finding a cheaper way to make glass, or quit entirely.

One of the more aggressive figures in the industry put the situation frankly up to his employees. He felt he could get the orders that would keep his plant running if he could reduce his labor costs. Would they break away from the union scale? It wouldn't be necessary to cut the hourly rate; simply increase the number of pieces they would make in a turn.

One should note here that the present union scale is based on a system that was developed twenty-five years ago. The union determined at that time how many pieces of a given type of ware a man could make in a four-hour period. That was called a move. Every year since, the wages of the industry have been subject to annual revision. But, though the dollar rate has been changed several times, the number of pieces in the move, has remained almost uniformly constant. This despite the fact that countless gadgets have been developed in the intervening years that make it possible to turn out glassware far more quickly and with less effort. A shop, if it wanted to would be perfectly capable of turning out its four-hour quota in perhaps three hours with no great exertion, and then could sit around (if the boss would let it) until the time for the next move came around.

When it was put up to the workmen to increase the output of a move; or it might be put, to give the management a reasonable output for the wages it paid, the employees were willing to try the experiment. It worked. The lower cost made possible a 15 to 20 per cent cut in selling prices. The company began to get the business. The factory went on a full 40-hour week, and for the first time in months the workmen began to get a full pay envelope.

Other factories saw the light, and their employees too. Gradually there was a drift away from the union, and The factory went on a full 40-hour week, and for the union shop men making better wages. The so-called "established plants," where the union shops are retained, are working under a severe cost handicap and its workers are earning less money.

**To those unfamiliar with the prices at which glassware should sell, a slight calculation will help them appreciate the nature of this bargain. Sixty per cent of the selling price of hand made ware is labor, at union scale. The lowest price at which an established company can afford to sell stemware is in the neighborhood of $1.40. That would give a labor *cost* of 80 cents, exclusive of raw materials, overhead or profit.

Today, the existence or non-existence of a protective tariff is of no immediate consequence so long as war makes it impossible for Belgium and Italy to enter the American market. Our own factories are recovering their business and the men are going back to work. From a volume standpoint, all is well. Price wise, however, conditions are far from stable. With most cooperatives selling their glass on a strictly wage basis, with the marginal producers operating non-union shops, and with the older companies trying to meet low prices with high union labor, no stability is possible. Given time, however, the various parts of the puzzle will fit into place.

It will all fit into place, that is, if war time conditions continue and keep foreign glassware out of the domestic market. To speculate upon what may happen after hostilities cease, is unpleasant enough; but if the duty is cut again to 50 per cent, as Mr. Hull has proposed, we can expect another 1938.

It will be worse. With the end of hostilities, Europe will demobilize at least a part of her armies and her men will want jobs. Every nation involved will be looking for markets, not only to provide those jobs but to replenish their exhausted resources. The keenest kind of competition in all world markets is inevitable, and the one economic weapon Europe will have with which to regain its trade will be an ability to make goods increasingly cheaper. With its glass trades operated by cartels, controlling both selling and price wage rates, it will be comparatively easy to undersell the domestic hand made glass market. If a 16 cent hourly wage won't climb a 50 or even a 60 per cent tariff wall, then 14 or 12 cents will.

And yet Mr. Hull wants to reduce the tariff, and do it now. The fact that he ordered a tariff hearing last September to consider immediate revision of the Belgian treaty (downward, of course; trade agreements never increase the tariff), can only mean that he is willing to sacrifice the West Virginia glass workers in the hope of giving work to a greater number of automobile mechanics in Detroit. The sacrifice is a certainty; the compensation a hope. It's rather tough on West Virginia.

The present Trade Agreement set-up is un-American in principle.. It destroys property without due process of law. Neither labor nor industry is given a hearing.

When Congress enacts a new tariff, opportunity for debate is given; there are public hearings and the duly elected representatives of the people have their say—not only as to whether there shall be a new tariff, but whether each and every item shall be increased or lowered.

When the State Department negotiates a Trade Treaty, the policy is pre-determined by the Secretary himself. It is a policy of downward revision, or it could not be a Trade Treaty. At the hearings, the committee rules as irrelevant the basic question as to whether revision is desirable; the question simply is not permitted. The committee has its instructions, and these instructions are to select *which* industries shall be subjected to foreign competition.

Such important decisions, affecting as they do the basic rights both of the people and property should not fall within the province of any single individual to decide, in a democracy. The Constitution confers that responsibility upon Congress. The power should be returned to Congress.

OPAL GLASS

By NORBERT J. KREIDL and W. A. WEYL

Opal glasses belong to the group of light diffusing glasses. The diffusion of light may be brought about either by the scattering power of the glass surface or by the scattering power of small particles embedded in a clear glass phase. The first effect may be obtained by etching or sandblasting the glass surface. The second effect may be obtained by a large variety of procedures and glasses of this kind form the subject of this paper. Recently glass fibres have been used in a thin layer between two clear glasses (as thermolux glass) in order to obtain light diffusion. This multi-layer glass besides its optical effect has good heat and sound insulation properties.

Most of the early opal glasses or glasses of similar description such as alabaster glasses, were obtained by the introduction of tin oxide into the glass or the use of bone ash. Cryolite glasses were used to a much lesser extent. The tin oxide opal glasses were somewhat similar to the present day white enamels although somewhat harder.[1] Most of the phosphate glasses were rich in bone-ash and lime and accordingly hard to melt.

The successful manufacture of opal glasses on a cryolite basis in the Pittsburgh and Philadelphia area in the middle of the last century soon aroused the interest of scientists in this product. This interest was also greatly favored by the fact that at this time the increased use of artificial fertilizers caused a boom in phosphate prices which made the production of boneash phosphate glasses uneconomical.

H. E. Benrath[2] was one of the first investigators to study the cryolite opal glasses. Due to erroneous analytical methods he came to the conclusion that all the fluorine is evaporated on melting the batch and that alumina is responsible for the opacity. This theory prevailed for a considerable time and was still adhered to after its futility was well established by the careful studies of many investigators. Benrath explained the phenomenon by the statement that alumina destabilizes the glass and has a tendency to crystallize out of the melt; although at this time, by the work of Pelouze,[3] it was known that alumina is of considerable importance for the stabilization of high silica glasses and that it prevents their devitrification.

In 1869, C. P. Williams[4] recognized the importance of fluorine for opacification and attributed opacity to the formation of sodium silicofluoride.

With the growth of the opal glass manufacturing industry, especially in Pennsylvania, the substitution of cryolite by other fluorine compounds became more and more interesting and sodium fluoride and fluorspar were tried.

C. Weinreb[5] in his investigations on the replacement of cryolite by sodium fluoride and alumina hydrate came to the conclusion that it is aluminum fluoride which causes the opacity. R. Zsigmondy[6] also adhered to this theory. E. Enquist[7] went so far as to advocate the theory that opacity in fluorine bearing opal glasses is due to gaseous silicon fluoride, a theory which for some time held its place among the other theories which were mostly based on mere conjecture only. The first to attribute opacity to the formation of sodium or calcium fluoride was Tedesco[8] who also claimed that the use of sodium fluoride and alumina separately has the advantage that the alumina content may be better controlled.

This short review of the early literature shows that the main interest was always concentrated on fluorine opal glasses. In this paper it is attempted to deal with all different types of opal glasses although here also the main emphasis will be on the fluorine opal glasses.

Optical Properties of Opal Glasses:

The optical properties of opal glasses are determined by the fact that opal glasses comprise two phases. One phase in all cases is a transparent glassy phase while the other phase may vary widely in its characteristics. In any case this second phase will consist of more or less finely distributed particles suspended in the transparent glassy phase. These particles must have different optical properties from the surrounding glass to cause refraction, diffraction and reflection. The main properties of this dispersed phase, i.e. of the opacifier, which determine opacity are the refractive index, dispersion, particle size and shape. Besides these properties of the opacifier proper a decisive factor is the particle distribution and the absolute number of particles.

The influence of these various factors have been intensively studied by various investigators[9] and in the following, the main findings will be briefly reviewed.

Generally speaking, the diffusion will increase with an increase in the difference of refractive index of the opacifier and the glass. However, with increasing difference the reflection of light will also increase, and thus the amount of light transmitted will decrease. In plant practice not much can be done about this factor since there is not much difference in the refractive index of the several opacifiers used and, in addition, the refractive index of the base glass can only be changed within certain limits. In this respect the beneficial effect of lead oxide may be mentioned. Lead oxide increases the refractive index of the glass substantially. It may be noted that in other ceramic arts this property of the lead oxide is used to decrease opacity. For example, colored glazes may be made to appear more brilliant by the use of lead oxide in case the glazes are rendered opaque by substances having a higher refractive index than the glaze. This is due to the decrease in opacity which reduces the whitish character of the glaze. Of course, in glasses or enamels which are opacified with tin, titanium or zirconium, opacity would be reduced on introduction of lead.

Small particles having dimensions of a magnitude less than a wave length which, according to Lord Rayleigh's law for light diffusion by particles smaller than the wave length of light, will cause the diffusely reflected light to be more bluish, thus giving a more reddish appearance to the transmitted light. With increasing particle size this selective action will be less and less pronounced.

Also with increasing particle size the total amount of diffusely transmitted light will increase as has been established by E. Lax, M. Pirani and H. Schoenborn.[10] The diffusion power of a glass will also increase with an increase in the number of particles, however, partly at the cost of total transmission.

It was also found by G. Gehlhoff and H. Thomas[11] that the loss in light intensity by absorption in opal glasses is due, to a substantial degree, to the opacifier particles rather than to the increased light path and that therefore the absorption loss might be decreased by reducing the particle number and increasing the particle size. This fact appears to be well confirmed by practical experience.

Well opacified glasses have as a rule ideal scattering power and up to about an observation angle of 60° the intensity of the diffuse light is almost uniform.[12] The less opaque a glass (assuming the same particle size) the less will be its scattering power.

Very little is known about the influence of particle shape. One curious effect however can be observed in plant practice. Shaping opal glass into rods or tubes often leads to a characteristic silky gloss, caused by an orientation of the crystals which deviate sufficiently from the spherical shape to be affected by the deformation of the glass. This effect resembles the aventurine glass, where by blowing and drawing, the thin plates of metallic copper or chromium oxide are caused to orient themselves parallel to the glass surface.

It need not be mentioned that the opacifier always should be uniformly distributed throughout the glass.

Types of Opacification:

As mentioned in the introduction the character of the dispersed phase in opal glasses or, in other words, of the opacifier may be of widely varying nature. The following classification of the various types of opacifiers takes into consideration both the process of formation of the disperse phase and its ultimate state in the glass:

I. Crystals formed by crystallization from the melt.
II. Introduction of crystals insoluble in the melt into the batch.
III. Two glassy phases formed by immiscibility.
IV. Gaseous bubbles in the glassy phase.

As is assumed in the case of phosphate opal glasses the formation of two liquid phases may precede the crystallization.

Opacification by Means of Crystallization:

As is well known, crystallization of the opacifier may take place on cooling of the melt and on reheating or striking of the glass.

The crystallization of supercooled melts has been intensively studied by G. Tammann and his school. From theoretical considerations he concluded that homogeneous melts, when supercooled, have a region of maximum crystal growth and nucleus formation. Both regions overlap more or less. In certain supercooled liquids the zone of nucleus formation will be at lower temperatures than the zone of crystal growth, allowing arbitrary regulation of the number of crystals formed (time of heat treatment at optimum temperature for nucleus formation) and size of crystals (time of heat treatment at temperature for maximum crystal growth).

The composition of technical opal glasses furnishes a much more complex system than those for which Tammann's theory may be exactly applied. However the fundamentals of Tammann's theory make us appreciate the importance of heat treatment for this type of opal glasses. As a rule the cooling schedule for each opal glass is found by trial and error methods and exact temperature ranges for optimal nucleus formation and optimum crystal growth are not known. Also our knowledge of the influence of glass composition and viscosity on these factors is very limited. In some cases it has been stated that rapid cooling favors the formation of small crystals and that a relatively low viscosity at the precipitation temperature favors formation of larger crystals.[13] In any case, the time factor will be very important and it should be expected that the composition of the glass is also of considerable influence.

Plant experience shows that as a rule rapid cooling will lead to less opaque an eventually clear glasses while denser opal glasses will be obtained by reaching the striking temperature by reheating rather than by slow cooling. Opal glasses which lend themselves particularly well to this latter type of opacification are called "striking" opals in Bohemia.

H. H. Blau[14] described one opal glass in which the two zones are separated. These glasses remain clear when cooling through the zone of crystal growth so that only by reheating first to the zone of nucleus formation and then to the zone of crystal growth a "controlled" opacification is claimed.

All these conditions are closely related to such colored glasses as the ruby glasses. The term "striking" is derived from the art of making ruby glasses. The properties of this type of colored glasses, therefore, would deserve joint study with the problems involved in opacification by crystallization.

The phenomena which have just been discussed also bear close relationship to those leading to devitrification. Although devitrification is amply discussed in glass textbooks it is never discussed in connection with opacification. This seeming oversight may be easily explained.

Whenever the physico-chemical background of crystallization is under consideration it is done with reference to equilibrium conditions, under which silicate systems crystallize according to their liquidus diagrams. On account of the slow reaction rates in most technical glasses such crystallization does not take place under ordinary operating conditions.

On the other hand where devitrification is discussed in connection with defects occurring in actual plant practice this refers only to local crystallizations. Usually this leads only to small amounts of crystals which sometimes are of comparatively large size. The crystals formed by devitrification are mostly formed by the major glass constituents.

Generally speaking devitrification is just as objectionable and noticeable in opal glasses as it is in clear glasses. It may be mentioned that under prolonged heat treatment cristobalite formation can be easily obtained in fluor opals due to the mineralizing effect of the fluorine ions. W. Buessem and W. Weyl[15] found in some opal glasses by X-ray and petrographic examination the presence of large amounts of cristobalite which showed fine cracks from the high-low inversion and therefore contri-

buted substantially to the opacity. However, these glasses were by no means technical glasses and had been prepared by G. Gehlhoff, K. Kalsing and M. Thomas[16] for their theoretical investigations on the influence of glass composition on the physical properties of fluorine opal glass.

Opacification by Means of Devitrification:

In some cases devitrification has been intentionally used to produce opacity; this group of glasses is of more theoretical interest.

An early example of glass opacification by intentional devitrification is Reaumur porcelain which was developed by Reaumur in 1772.

Another case of intentional devitrification is based on the phenomenon of seeding, that is, causing crystallization by the introduction of small amounts of the crystal desired. Technically this may be carried out by devitrifying a glass and introducing this devitrified glass as ground cullet into a glass batch. In this way devitrification may be controlled to give an evenly opaque glass.

In the British Patent 195,495 devitrification of glasses of the pyrex type is claimed as another type of opacification by devitrification. There devitrification is probably preceded by the formation of two glassy phases, as glasses of this type of composition as a rule show more or less tendency toward immiscibility. Accordingly such borosilicates could also be grouped together with phosphate opal glasses.

Fluorine Opal Glasses:

The importance of the element fluorine for opacification may be attributed to its small atomic radius and accordingly to the strong forces exerted on the neighboring atoms. The strong interaction of fluorine and its surroundings will favor the formation of an orderly crystalline lattics or, in other words, give rise to a strong tendency for crystallization. Another factor in this connection might also be the high symmetry of the fluoride crystals. The high symmetry of a crystal favors the arrangement of the constituent ions to build up its lattice. This may be illustrated by the fact that cristobalite due to its high symmetry (cubic crystals) crystallizes out in the stability field of the less symmetrical (hexagonal) tridymite.

In technical glasses fluorine is usually introduced together with alumina, and opacification may be attributed to the formation of fluoride crystals. The size and number of these crystals are determined by the factors discussed in a previous section but also are largely influenced or regulated by the presence of certain oxides, particularly bivalent oxides.

Much theoretical work has been done on opal glass and by way of example reference may be made to the work of G. Agde and H. F. Krause,[17] H. H. Blau, A. Silverman and V. Hicks,[18] K. Fuwa,[19] A. Granger and M. Babille,[20] F. Doerinckel[12], G. Gehlhoff, K. Kalsing and M. Thomas,[16] J. W. Ryde, D. E. Yates,[22] and W. Weyl and W. Buessem.[15]

Although some of the results are contradictory, some general conclusions may be drawn. It appears that in all fluorine opal glasses opacity is caused by sodium fluoride and by alkaline earth fluorides, such as calcium fluoride. Calcium fluoride will especially contribute to opacity in glasses rich in lime. It also appears to be well established that these crystals will be responsible for the opacity regardless of the form in which the opacifiers have been introduced and independantly of the presence of alumina. It was not possible to detect in glasses opacified with cryolite any other crystalline material than sodium and alkaline earth fluorides.

The fact that in technical opal glasses the presence of alumina is almost a necessity seems to be in contradiction with these findings; however, in a later part of this paper we will attempt to explain this fact.

The independance of opacification of the form in which the fluorine is introduced into the batch appears to be established not only for the kind of crystals formed but also for the development of the optical characteristics of the glass, if the composition of the melted glass and the heat treatment is kept constant. This was confirmed in a series of large scale experiments using one to three ton day-tanks which showed that slight changes in the composition of the melted glass caused a substantial change in opacity whereas, with constant composition, replacement of one fluoride by another had practically no influence. The opacity of the glasses was checked with technical light output measurements which indicated that these finding hold good to a more than generally qualitative degree.

Keeping this in mind it would appear that fluorine may be introduced by any of the commercial products such as cryolite, synthetic cryolite, sodium silicofluoride, fluorspar or minerals containing fluorine. Of course selection of any of these materials will not be only determined by the properties of the final glass but also by their influence on the melting properties, purity, etc.

A question which has caused much controversy is the fluor loss on melting. Here also, we will summarize only those theories that appear to be most probable. The main loss usually appears to be in the form of fluorides or hydrofluoric acid especially in the form of sodium fluoride which has a rather high vapor pressure. Sodium silicofluoride has a tendency to be decomposed to SiF_4, which may readily evaporate. It is also claimed that SiF_4 may be evolved from glasses rich in fluorine. Possibly many of the seeming inconsistencies in the results obtained by the various investigators may be attributed to the fact that the fluorine loss is not only determined by the fluorine compound introduced into the batch but, in many cases, probably to a far greater degree by the composition of the glass, which in different cases might lead to the formation of different fluorine compounds as intermediate products in the melt.

As may be seen from the preceding selections the influence of temperature and temperature-time conditions are of extreme influence on the development of opacity in fluor opal glasses. The regularity of heat treatment should be carefully checked before one may attribute any results to chemical factors or change in batch. Studies of the influence of chemical composition on crystallization, and accordingly on scattering power, light transmission and reflection, require extremely high constancy of experimental conditions. This is especially true for small scale experiments. Results in the above mentioned experiments on the influence of various fluorine compounds in glasses of the same melted composition proved the high constancy which may be obtained in such a technical setup.

The mechanical properties of fluorine opal glasses are prevailingly governed by the relation of the two phases. It is known from the work of A. Smekal that even in one phase glasses such as flint glasses, the occurrence of local flaws (Lockerstellen) determine the mechanical properties of a glass, such as its tensile strength, to a much greater degree than what might be called the ideal tensile strength of an ideal glass of flawless structure. It may be noted that such a flawless glass cannot be obtained even under the most careful conditions. As a rule therefore, tests with larger pieces of glass will give rise to results indicating an inferior mechanical strength than with smaller test pieces since the probability of flaws will be much greater in a large test piece than in a small one.

It is obvious that these phenomena will be much more pronounced in two phase glasses such as the fluorine opals. Any theoretical assumptions on mechanical properties will not only be altered by the flaws occurring in the glassy phase but to a much greater degree by the macroscopic structure of the crystalline phase.

Size and shape of the crystal phase will be the decisive factors for the mechanical properties.

As a characteristic example of these influences the brittleness of fluorine opal glasses may be mentioned for which we may state the following practical conclusions:

The brittleness of fluorine opal glasses keeping all other chemical and physical influences constant according to our own findings and to those of G. Gehlhoff, and M. Thomas[23] and of J. F. Hyslop[24] depends for example on:

a. The crystal size and shape.
b. Content of basic oxides, especially zinc oxide, which in turn influence crystal size and shape.
c. Working temperature.
d. Inhomogeneity of crystal size such as caused by different cullet.

The Influence of Chemical Composition on Fluorine Opal Glass:

A complete study of the influence of chemical composition on opal glass is met by serious difficulties. The variety of possible glass composition even when considering only simple compositions, as those which have been studied by G. Gehlhoff, H. Kalsing and M. Thomas,[16] and glasses which are within the range of compositions used in plant practice comprises such a number of variables that it appears to be all that can be done at the present time to generalize for each of the variables under consideration, always keeping in mind the limitations of our knowledge. The conclusions with respect to the different variables also apply to their effects when used in fairly conservative glasses subjected to conservative heat treatment (striking).

The following discussion deals with what we have learned from plant experience, literature and from our recent systematic studies on opal glass which were carried out to widen our knowledge by systematic plant experiments. One of the authors has carried out large scale experiments which still are under continuation, the results of which however, as far as they allowed conclusions at this early state of the work, have been incorporated in the following. These large scale experiments were undertaken to study the influence of K, Na, Mg, Ca, Zn, Pb and B_2O_3 on fluorine opal glasses. That far, 100 three ton melts were made in day tanks, 80 of which were in the field of the system A and twenty in the system B as given in the following table:

	System A	System B
SiO_2	58–62%	About 70%
Na_2O	7.7–11.25%	15%
K_2O	2.5–5.5%	3%
CaO	4.5–8.57%	1–2%
Al_2O_3	5%	2.5–3.5%
B_2O_3	0–3%	
PbO	0–7%	
ZnO	0–5%	
F	7–8%	5–7%

It may be noted that in many cases the results of G. Gehlhoff, H. Kalsing and M. Thomas,[16] were confirmed by our findings.

(a). *Influence of Alumina*: Alumina certainly is one of the most important constituents of fluorine opal glasses and it might be stated that its presence is absolutely necessary. As a rule it is introduced in amounts furnishing an alumina to silica ratio of about 5 to 100. This great influence of alumina has always impressed on the glass maker the idea that aluminum fluoride is responsible for the opacity. This assumption, however, could not be confirmed by X-ray investigations and has been abandoned. The question as to what causes this characteristic action of alumina is still open. As a possible explanation which, however, would need experimental confirmation the following theory may be offered. During melting the fluorine and aluminum form the complex anion AlF_6--- which is of a rather stable nature thus preventing a substantial loss in fluorine. Only when the temperature is lowered after melting, sodium fluoride or alkaline earth metal fluorides are formed. Some evidence for this theory may be gathered from the findings by J. Enns[25] who found that trivalent iron forms rather stable complexes with fluorine of the composition FeF_6--- which gives a bluish color to clear fluorine glasses since the FeF_6--- complex is colorless and therefore only free divalent Fe ions are present and these have a blueish color.

Besides this effect of alumina which is characteristic for fluorine opal glasses it has here the same well known stabilizing action as in clear glasses, that is, it prevents devitrification.

Felspar, cryolite and hydrate of alumina are the most popular raw materials for the introduction of alumina. Wherever the content of felspar in potassium may be disregarded materials with a higher Al_2O_3 content may be used instead, with some advantage in cost, provided that the alumina content is known and dependable (nepheline syenite). In Bohemian plant practice the potash content of felspar is considered of such importance that such a replacement would not be considered as economic.

From a scientific point of view replacement of one alumina compound for the other when constancy of the melted composition is provided has no influence on the glass. This has also been confirmed by our own experiments as stated in a previous section.

(b). *Influence of alkali content:* The alkali content has a far smaller influence on crystallization of the fluorides than any of the other oxides if not present in extremely high or small amounts. It is often stated that high viscosity is necessary for obtaining good opal glasses. Since increase in alkali decreases the viscosity for a

given temperature it might seem that the opacity would also be decreased. However, the alkalies also decrease the melting range so that on the whole nothing is changed. In fact considerable amounts of alkali may be added to a fluorine opal glass without affecting the opacity.

Potash improves the appearance of opal glasses just as it does in colored glasses. Continental opal glasses, especially Bohemian opal glasses, are usually high in potash while American opal glasses as a rule do not contain more potash than is furnished by the felspar.

(*c*). *Influence of Lead oxide:* Lead oxide increases the difference in refractive index between the glassy phase and the fluorides thus increasing their scattering power. The influence on crystallization in the range of usual compositions and as studied in our experiments is between that of calcium oxide and zinc oxide. In this country lead oxide is usually introduced as litharge or more recently as lead silicate while in Europe it is introduced, if at all, as minium which allows a decrease in the amount of saltpeter, and is free from metallic lead.

(*d*). *The influence of Zinc oxide:* Zinc oxide has been found to increase the rate of crystal growth and zinc containing fluorine opal glasses show distinctive optical properties. The use of zinc oxide (especially in combination with boric oxide) makes it possible to produce glasses which have a high scattering power and high light transmission and a less blueish and chalky appearance than glasses of equivalent opacity but free from zinc. As in the discussion of the other oxides influence on the glassy phase is not emphasized but in the case of zinc oxide it may be noted that it improves chemical and thermal resistance in the same way that it does in flint glass.

(*e*). *Influence of Magnesium and Calcium Oxide:* In the range of glasses studied these oxides decrease the opacity. The importance of calcium oxide for fluorine opal glass lies in its tendency to increase crystal growth. Glasses high in calcium oxide mainly those opacified with fluorspar have a characteristic appearance. In Bohemia such glasses were called spar glasses. Formerly these spar glasses were melted in combination with felspar without the addition of any other fluoride than fluorspar. Fluorspar is the cheapest source for the introduction of fluorine but due to the influence of calcium oxide more fluorspar has to be introduced.

(*f*). *Influence of Boric oxide:* Boric oxide substituted for alkali increases the light transmission and in addition imparts to the glass the advantages encountered in other glasses. Its effect in combination with zinc oxide has been mentioned in the paragraph on zinc oxide.

In Germany replacement of zinc oxide by Sioto, a commercial product containing barium oxide and boric oxide has been recommended. Some scouting experiments showed a decrease in opacity with Sioto but nothing definite can be stated as yet.

(*g*). *Influence of Barium oxide:* Barium oxide as reported by Gehlhoff is more favorable than calcium oxide in opacification.

In the following table some typical examples of various types of fluorine opal glasses are given:

TYPICAL FLUORINE OPAL GLASSES

I. "Spar" Opal Glasses

	A	B	C
Sand	100	100	100
Soda Ash	30		
Potash		28	32
Limestone	10		
Felspar	12		15
Fluorspar	12	15	15
Lead Oxide		30	50
Saltpeter			6

Formula A is a German opalescent glass; formula B is French and formula C is English.

II. Cryolite Opal Glasses

	A	B
Sand	100	100
Soda Ash	9	
Potash	10	17
Limestone	10	
Lead Oxide		8.7
Boric Acid		3.2
Cryolite	14	16.4

Formula A is a typical Bohemian cryolite opal glass.

III. Fluorspar-Cryolite Opal Glasses

	A	B	C	D
Sand	100	100	100	100
Soda Ash	11	25	17	12
Potash	20	6	8	
Felspar	30	60	4	35
Fluorspar	11	28	12	15
Cryolite	12	2	5	11
Sodium Silicofluoride		4		
Alumina	0–5	2	4	
Lead Oxide		5		3.5
Borax		3		30
Sodium Nitrate			2	3
Zinc Oxide			11	11

Formula A is a German type, formula B and D American and C French Opal glass. Formula B represents a lead containing and C a zinc oxide and D a zinc oxide and boric oxide containing opal glass.

Here and later, wherever possible as examples, glass batches have been selected which are fairly representative for actual plant practice. Some of the examples are taken from the literature.

Opal Glasses Opacified by Addition of Insoluble Crystals to the Batch

All opal glasses belonging to this group are rarely used for commercial glasses. This type of opacification however is the usual type encountered in enamels and glazes.

a. Tin oxide: Tin oxide gives a high grade opacification. Some technical compositions as sometimes used in the glass industry may be given by way of example:

	I	II	III
Sand	100	100	100
Soda	30	20	
Potash	5	15	20
Lime	10		
Felspar		18	
Fluorspar		9	
Minium	6	6	
Sodium Nitrate		5	
Borax	8	2	10
Tin Oxydal	2	6	5.5
Lead Oxide			108.5
Arsenic	1.3		17.5
Cream of Uarter	3.5		
Phosphate of Calcium			8.5

No. III is a glass which has been used for casing purposes.

b. Antimony and arsenic compounds: These compounds are practically restricted to lower melting glasses in their use, note however their use as additional opacifiers in the above examples.

c. Titania and Zirconia: Higher amounts of these ox-

ides are not soluble in ordinary glasses. Their value for opal glasses would need some experimental studies.

d. Magnesia: Magnesia in larger amounts may be insoluble in not too high melting glasses and give rise to rather large, regular fluffy particles providing an opal glass of a particular appearance. It is shiny and whitish as it does not show the diffraction effects found in regular opal glasses. Glasses of this type are sometimes called moonstone glasses in this country and New Venetia in the Bohemian trade. This type of opal glass in white and colored shades has been used as a stone imitation in illuminating ware.

In the production of these glasses usually the magnesia also replaces the lime entirely, no other bivalent oxides being necessary. At least as prepared originally these glasses did not contain any soda but potash only. The magnesia may be introduced as magnesia usta or as talcum.

The following batches are given by way of example: I. Sand 100, potash 40 or more, borax 5, magnesia usta 10. II. Sand 100, potash 40 or more, borax 5, talcum 5.

Opal Glasses Produced by Immiscibility:

Under certain conditions some glass compositions on melting will give rise to immiscibility phenomena; that is, two glassy phases will be formed which are not soluble in each other. Such immiscibility will lead to opal glasses if one of the glassy phases is finely dispersed in the other one and has different optical properties. In the large variety of possible compounding of poly-component systems as glasses, the conditions for immiscibility of many glass compositions are well known. This principle has found commercial application only in phosphate opal glasses.

Phospates are soluble in melted silicate glass to a certain extent but have a strong tendency to show immiscibility and to crystallize partly during cooling. Opaque phosphate glasses have been studied by O. Inwald[26], E. Zschimmer, K. Hesse and L. Stoess[27] and others.

The presence of CaO in the glass has been found necessary for the production of phosphate opal glasses as it is calcium phosphate glass which is immiscible with silicate glass. On cooling the phosphate glass phase may devitrify to some extent so that the final opacification is due to crystals rather than a glassy phase.

The addition of phosphates to silicate glasses raises the softening point of the glass and danger arises that on cooling down, larger lumps of phosphate glass may be formed which render the surface of the glass rough. This defect can be partly overcome by working the glass at high temperatures. It is more desirable to use glasses richer in lead oxide or boric oxide which allow working at somewhat lower temperatures without formation of a rough surface.

Phosphate usually was introduced as bone ash and the resulting opal glasses were sometimes called bone glasses. In present day practice the phosphate is introduced as calcium phosphate.

Due to the larger size of the opacifying particles in phosphate opal glasses they have a somewhat different appearance than the fluorine opal glasses and they are used for special illuminating effects for example under the name of Alba glass. In Bohemia this type of glass was called Venetia.

The table gives two typical examples of such opal glasses:

	Venetia or Opalescent Both glasses by variation of the phosphate content may be obtained opalescent or medium opaque (Venetia) the formula to the right being a lead glass.		Denser Phosphate Opal
Sand	100	100	100
Soda	3		10
Potash	32	60	30
Lime	14		4–9
Lead		5–7	
Saltpeter			2
Calcium Phosphate	8–18	8–18	18–22

Miscellaneous Opal Glasses With Mixed Opacification:

In many commercial formulas use is made of mixed opacification. In the following some formulas are given for the sake of completeness:

a. Old Bohemian Alabaster, opacified with talcum and phosphate:

Sand	100
Potash	37-45
Saltpeter	5-6
Bone Ash	6
Talcum	3-5

b. Phosphate-Tin-Arsenic Opal:

Sand	100
Potash	21
Lead Oxide	107
Borax	8.5
Boneash	10.2
Tin Oxide	5.4
Arsenic	8.7

c. Resistant phosphate and phosphate magnesia:

	Transparent Opal (Opalescent)	Opal	Opal For Lamp Chimneys
Sand	100	100	100
Hydrated B_2O_3	33		66
Borax	50-60	60	
Bone ash	4	10	3-11
Salt cake	8.5		
Arsenic	1.5		
Ammonium sulfate	5.5	1	
Zinc oxide		3-4	
Sodium nitrate		1.6	
Alumina		5	4.5
Soda			15
Potash			1.25
Magnesia			6

d. Fluroine-Tin opal:

Sand	100
Soda	20
Potash	15
Felspar	18
Fluorspar	9
Pbo	6
Saltpeter	5
Borax	2
Tin Oxide	6

e. Phosphate in combination with fluorine has also been used for producing opacity.

Chloride Opal Glasses:

This opacification is mostly ascribed to the action of chlorides on opacifiers[28]. Especially in fluoride glasses it was found that addition of chlorides in the form of sodium chloride causes the segregation of larger particles. This phenomenon is made use of in practical glass making in this country and in Bohemia. Large additions of

(*Continued on page* 82)

CORNING INSTALLS PROPANE SYSTEM

Recent difficulties with the supply of natural gas has compelled the Corning Glass Works to install a propane stand-by system. Three tanks, each of 30,000 gallons capacity, have been provided for the Corning factories and one tank of that size for Wellsboro. The accompanying illustration shows the former installation as it appeared in early December.

Although Corning has been operating with natural gas in recent years, it originally manufactured its own fuel and continued on that basis until as recently as six years ago. Then, a number of local gas wells were brought in, and the glass works became one of the first of several large industrial plants to change over all of its equipment to natural gas. The nearness of the fields and the low cost of the fuel made the shift justified. In fact, the Corning Glass Works leased a considerable tract of land and put down its own test well. No gas was found and the well was abandoned.

Last fall, however, gas pressure at Corning dropped from the usual 25 to 26 pounds to below four pounds, seriously hampering glass melting, and requiring costly alteration in production schedules and even shut-downs. In the Wellsboro section, industrial customers of one large utility company have been notified that service could not be maintained much longer as pressure in the wells was diminishing, and it is reported that the gas company has filed with the Commission a petition to discontinue its service.

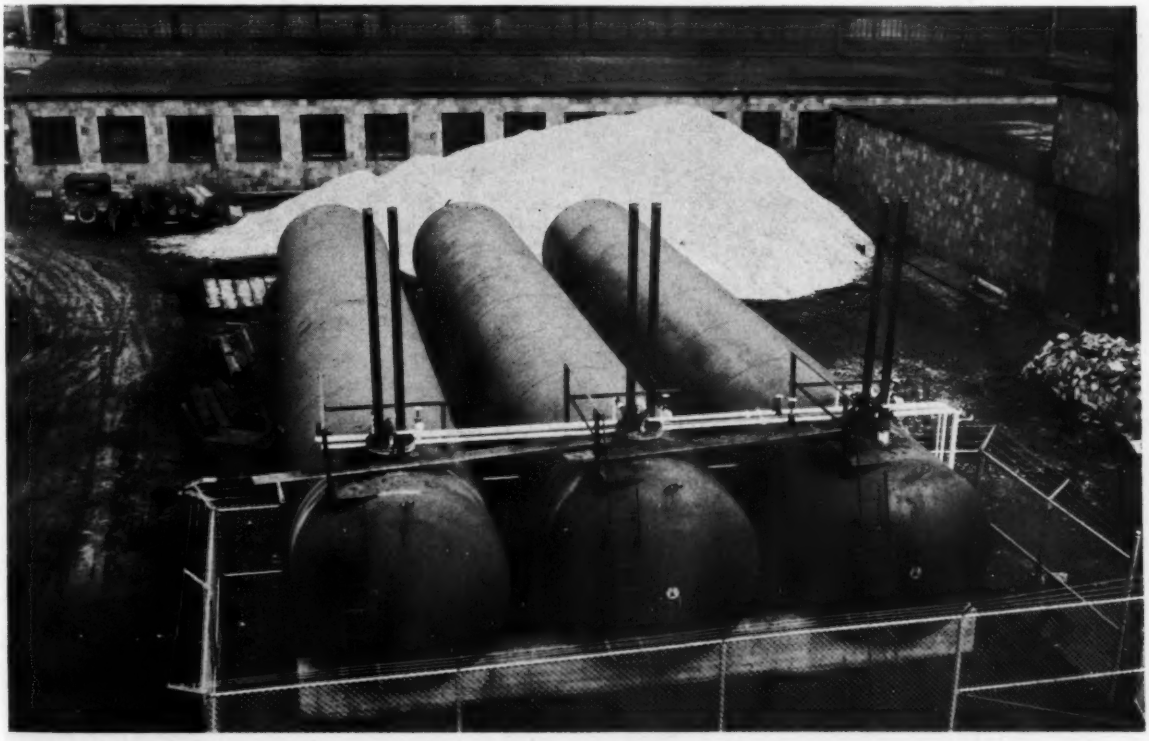
At the same time that Corning decided to install its propane system, the company began drilling again on the Alger lease, a few miles from Corning. The test well has come in with a limited flow and has been cased. Efforts to find an independent supply of natural gas are being continued and drilling will be resumed shortly.

L-O-F ANNOUNCES NEW SILVERING PROCESS

Libby-Owens-Ford Glass Co. announces the purchase of the Peacock Laboratories, Inc., Philadelphia. The laboratories will be operated as an independent unit, continuing under its own corporate name under the direction of its president and founder William Peacock. The new affiliate puts the Libby-Owens-Ford Company in the business of manufacturing and distributing silvering solutions, mirror-backing materials and similar supplies, in the development of which Mr. Peacock has earned a nation-wide reputation.

Libby-Owens-Ford also announces at this time a new silvering process, which it will make available immediately to the mirror industry. Under present methods, it usually requires a half hour to silver a 12-foot square area of glass. By the new process, the time is cut to 57 seconds. An important factor in this time-saving is the new method of spraying the silvering, rather than pouring it on and then allowing it to smooth out and float across the surface. Materials and labor costs are cut, and the mirror thus silvered is of far better quality, being clearer and more brilliant.

• S. Frank Cox has been appointed technical director of the double glazing department of the Pittsburgh Plate Glass Company. His duties will be to coordinate and advance the development of double glazing activities. Mr. Cox was formerly connected with the Pittsburgh Corning Corporation in a technical sales capacity.



View of the 30,000 gal. Propane tanks at Corning, N. Y., installed because of failing pressure of the natural gas supply.

MARBLE MANUFACTURE AT PELTIER GLASS COMPANY

The inventive genius of the Peltiers has successfully met the competition of foreign importations from low-wage countries, as well as the economic problem of a short operating season. In spite of the secrecy in which all American marble manufacturers clothe their methods, Mr. Sellers Peltier has generously permitted The Glass Industry to inspect his factory and give a general description of some of its operating practices.

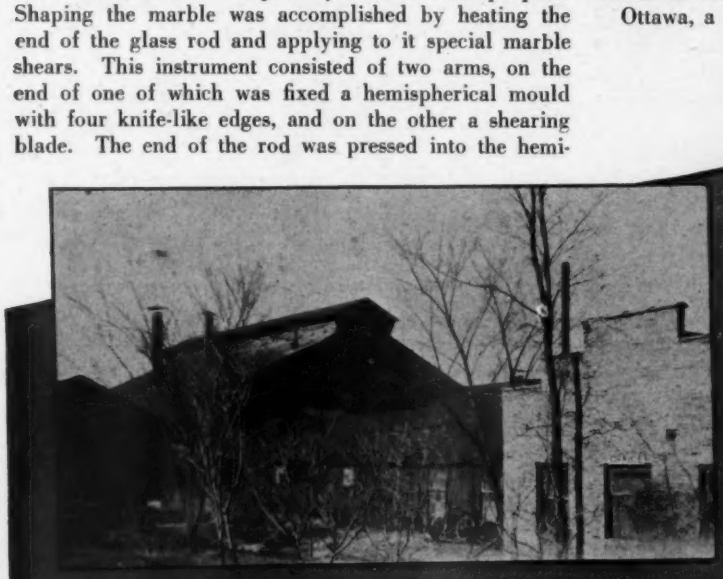
Marbles are probably the most ancient plaything of man. A recent magazine article describes as "the oldest sporting event in England" the annual Marble Tournament held in Tinsley Green since 1858. This year 4,000 spectators watched eight teams of seasoned marblers, six men to a team, gravely kneel around a concrete bed and endeavor to knock off their opponents' marbles.

There has been an enormous increase in the use of marbles in the last fifteen to twenty years, which was fostered by an equally startling decrease in their cost through the invention of automatic machinery for producing them. In common with other articles made of glass, marbles were formerly fashioned by hand from rod or cane, which was especially drawn for this purpose. Shaping the marble was accomplished by heating the end of the glass rod and applying to it special marble shears. This instrument consisted of two arms, on the end of one of which was fixed a hemispherical mould with four knife-like edges, and on the other a shearing blade. The end of the rod was pressed into the hemispherical recess and the shear arm manipulated so that the finished marble was cut off. Each heating allowed the production of eight to ten marbles, the output varying from 70 to 500 marbles per hour depending on the size of the marbles. With the most up-to-date machines now in use, three men can produce 8,000 to 10,000 marbles per hour.

The price of the smaller sizes of marbles made by the old "shearing" process was ordinarily about six for five cents. Now the same amount of money will provide the purchaser with thirty marbles more mechanically perfect than could be produced by the old method. Costs as low as these have enabled American manufacturers to hold the domestic market against importations from foreign countries. The chief competition has been Japan whose product, while making little progress in this country, has captured a large share of the foreign demand with an article of inferior quality.

Production in the United States varies from 500 million to over a billion marbles per year, depending largely on the requirements of new games for which they are used. This output is handled by some seven factories, four of which produce the bulk of the market's requirements. One of the leading companies in the latter group is the Peltier Glass Company of Ottawa, Illinois, of which Sellers H. Peltier is owner and manager.

Ottawa, a city of about 15,000 inhabitants, is located 85 miles southeast of Chicago at the junction of the Fox and Illinois rivers. The city has for many years been more or less a midwest center of glass manufacture. Its prominence in this field is due to the fact that it is built over enormous deposits of St. Peters sandstone, a rock composed of over 99 per cent pure silicon. The mining and preparation of this well known raw material of glass making is in itself a major industry of the river valleys.



The Peltier factory. Right, the door leading to the office.

Furnaces and marble machines. Note the grooves in the cylinder rolls of the latter.

Victor Peltier, father of the present owner of the Peltier Glass Company, came to Ottawa in 1882. He had learned the art of glass blowing in France and took up his trade with the Ottawa Flint Glass & Bottle Company, a manufacturing enterprise which had been established in 1867. Mr. Peltier's ability as an executive as well as an artisan, was soon recognized, and he was

advanced to the position of factory superintendent.

He later began experimenting with colored glasses at his home, an avocation which finally led to his starting a glass factory of his own. The new company specialized in the manufacture of stained and opalescent glass for ornamental windows in churches and other buildings. Mr. Peltier's two sons, Sellers H. and the late Joseph A., who had learned their trade under their father, were associates with him in this business. After several years of successful operation of the new business, Mr. Peltier, Sr., died in 1911.

During the next few years the demand for stained glass windows fell off appreciably, and the Peltier brothers began experimenting with the manufacture of marbles. They finally bought the patent rights to a machine which embodied the basic principle of the vastly improved machine now in use.

Marbles are made from the usual mixture of cullet and batch, and at the Peltier factory the mixing is done by hand. The glass is melted in small continuous furnaces which are built in the form of a "T" with a connecting chamber at the junction of the legs. This unusual arrangement of melting chambers is designed to allow various combinations of colors in the marbles. No regenerators are used with these furnaces, the heat being supplied by premix burners located in the ends of the melting chambers. Natural gas is used for fuel, a temperature of about 2,600° F. being maintained to secure good melting conditions. The furnaces are mounted on a steel framework at a height of approximately six feet from the floor. This arrangement provides room for the marble machine and an automatic feeder located immediately below the furnace.

Marble makers dispense with frills but are fastidious about equipment.

Sacking marbles with an automatic counter.

Batch is filled into the furnaces by hand through small openings in the side walls a short distance from the burners. If marbles of one color are to be made, batch of the proper formula is melted in the larger chamber only. If more than one color is desired, the glass for the body of the marble is melted in the larger chamber and different colored glass in the smaller chambers. The glass flows from the melting chambers to a common discharge opening in the bottom of the furnace where the different glasses blend to form color combinations. This opening is in line with the feeder which delivers the glass in gobs of the proper size to the forming machine below. Striking the paired rollers which comprise the forming machine, the gobs are rotated along spiral grooves around the circumference of the rollers, emerging as perfect spheres or marbles. At this point the marbles have cooled sufficiently so that they will not adhere when brought in contact with each other. They are discharged from the forming rolls directly into metal baskets where they finish cooling slowly enough to be sufficiently annealed for commercial purposes.

All of the product is carefully examined in the inspection department and defective marbles sorted out before being passed on to the packing department or storage.

Considerable care must be exercised in disposing of rejected marbles which, due to color combinations, cannot be remelted. These rejects must not be allowed to fall into the hands of neighboring small boys as they are perfect ammunition for sling shots, and an epidemic of broken windows always follows their disappearance from the scrap cullet bins. A stock of several million marbles in various colors and patterns is kept on hand in bins in the warehouse. This luckily is one product on which stain or bloom does not appear as a result of changing atmospheric conditions in the warehouse.

Marbles are packed in pasteboard cartons or mesh bags. The latter are manufactured for the Peltier Glass Company in a small local factory which produces about 3,000,000 bags between the months of December and April. Marbles are marketed through all the ordinary channels such as toy departments and chain stores, the latter being by far the largest customer. Orders for their delivery are usually placed in the late summer or fall with instructions to begin delivery after the first of the year. The season of greatest production, therefore, is during the first four months of the year when approximately 90 per cent of the annual requirements are manufactured. The Peltier factory during this season often produces three million marbles, approximately a carload, in 24 hours.

Playing marbles are made in over 50 combinations of colors and stripes, with about half of the output in solid colors. Of the various colors produced, red is very popular with children, as is also a specialty of the Peltier Glass Company known as a "Rainbow Stripe."

Due to popularity of the game of "Chinese Checkers," production has been much larger in the last two years, and in 1938 the Peltier factory alone produced over half a billion marbles. This output was marketed through the sales efforts of Berry Pink, who is known throughout the industry as the "Marble King." Mr. Pink, an expert himself at the national game of marbles, has utilized many unique methods of advertising the product. In his sales campaigns, he visits many schools and awards prizes of bags of marbles to the best spellers. He also promotes national marble tournaments and often competes himself in the championship eliminations.

The duration of the season is so short that it would be uneconomic for any business to make marbles the only item of production, and the Peltier Glass Company has expanded into other lines of glass ware to keep the factory busy during the balance of the year. Many glass novelties for the chain store trade are manufactured and lenses for automobile and truck lights are produced in large quantities on semi-automatic machines. Melting for this type of ware is done in day tanks, of which there are a number ranging in capacity from 1,500 to 4,000 pounds. Furnace temperatures are taken with a Leeds Northrup optical pyrometer. Some of the annealing lehrs have been built according to Mr. Peltier's own design. A new Frazier Simplex metal encased lehr has recently been installed which has sufficient capacity to handle the normal output of ware. Temperatures at the important points in the lehr are registered by a Brown Recording Pyrometer.

Due to his early training in the manufacture of colored glass, Sellers Peltier has an excellent knowledge of this branch of glassmaking. He personally works out the batch formula from which his colored glasses are made and follows his products through all stages of manufacture. His company has an excellent reputation for the high standard of its products and its policy in dealing with its customers. Its history is an example of the typical American method of meeting competition by sheer inventive genius. Due to this faculty, Mr. Peltier has been able to overcome competition from countries with low wage scales, while at the same time paying a scale of wages in keeping with the American style of living.

TO STUDY GOLD RUBY GLASSES

F. M. Veazie of the Ceramics Department, Pennsylvania State College, is making a study of gold ruby glasses under the direction of Dr. Weyl. Up to the present time most of the gold ruby glasses used for optical and signal purposes in this country have been imported from Europe. The object of the present investigation is to learn the conditions which lead to the most desirable colors so that melting on a large scale can be done on compositions which are not too sensitive to different heat treatments and, therefore, give reproducible colors under a wide range of manufacturing conditions. Considerable progress on this subject has been made already.

NEW TWO-QUART MILK BOTTLE

At a meeting attended by representatives of the glass container, closure, equipment and crate industries, held in Chicago on January 16, a new two-quart milk bottle was standardized. The accompanying illustration shows the new bottle by the side of its one-quart associate.

The two-quart bottle adheres to the general shape of the one-quart container, and requires only 25 per cent more space in the family refrigerator. It was tested with success on the Pacific Coast a year ago, and this year in Chicago it has already resulted in a 20 per cent increase in home-delivered milk consumption. By its adoption, it has been possible to standardize machinery and equipment used by the dairy industry.

The new two-quart milk bottle (right) compared with its more familiar one-quart counterpart.

U OF I CERAMIC RUKUS

The Student Branch of the American Ceramic Society, at the University of Illinois, presented its fourth annual Ceramic RUKUS on January 15. Nearly 100 couples danced to the music of a special orchestra "discovered" by seniors of the Ceramic Department on an inspection trip. A feature of all former Ceramic Rukuses, which has earned renown all over the campus, has been the program, always made of ceramic materials, and done by students on their own time as an extra-curricular activity. John Briscoe was this year's general chairman.

• The American Ceramic Society is planning a general session dealing with kiln and furnace operation, as part of its program for the annual meeting of the Society in April.

WAR DECORATION OF WINDOW FRONTS

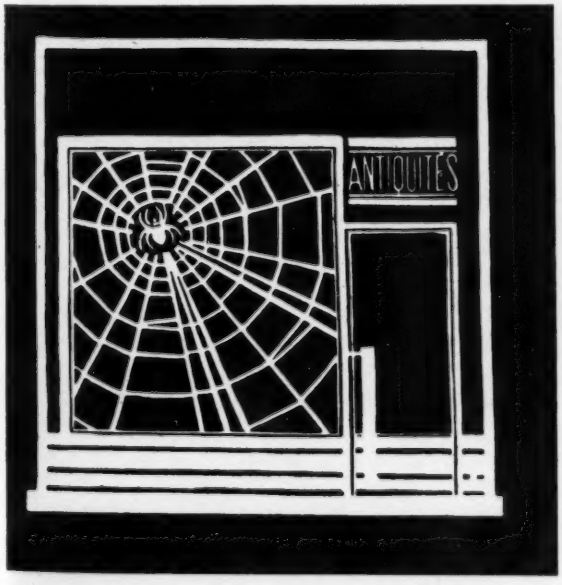
ABSTRACTED WITH ILLUSTRATIONS FROM "GLACES ET VERRES"

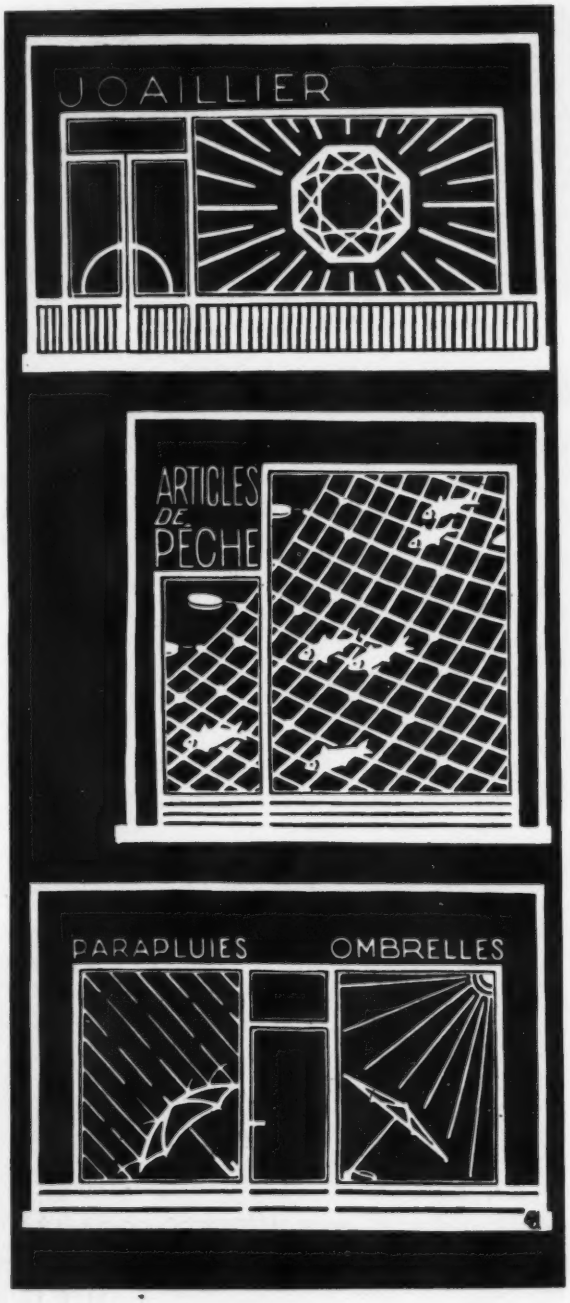
In all towns threatened with bombardment there have reappeared the strips of adhesive paper which were used in 1914-1918 to protect window-panes, to some extent, from breaking through vibration, but even more from scattering fragments and causing injury if they should get broken. The bands of paper serve to hold the broken window together; provided, of course, that the strips are wide enough, and of sufficient strength, and fairly close together.

It is not suggested that these strips of paper are as efficient as a proper reinforced glass or safety glass. Nevertheless, they constitute a precaution which is far from useless, and which should not be neglected. Another method is to paste transparent or translucid paper over the whole window, thus creating a sort of "Triplex" glass; but we are concerned at the moment with the strips of adhesive paper, which if artistically applied, can be both a pleasure to the eye and an effective means of publicity. We have seen a few in Paris, for instance, which had real artistic merit; but rather than produce photographs of existing windows, we asked our designer to submit suggestions for different merchants, and we illustrate here some of his ideas.

One wonders if, even in peace time, window fronts could not be used more to attract the eye of the passerby; soluble paint could perhaps be used, as being easily renewed. At any rate, in war time, and used with taste and discretion, these strips of paper seem worthy of much greater favor.

The story in this column was abstracted from the July-November issue of *Glaces et Verres*. The illustrations, also, are the creation of that publication, whose design department has applied artistry and salesmanship to the technical solution of a problem, we think, with most happy and unusual results.





Shock resistant window fronts where antiques, jewelry, fishing tackle and umbrellas are offered for sale.

LEON J. HOUZE, SR.

Leon J. Houze, Sr., president of L. J. Houze Glass Company, died in a hospital at Albuquerque, N. M., on January 22. He had been in California visiting one of his sons, Norman C. Houze, and was making the trip to his winter home in Orlando, Florida, when stricken with a heart attack.

Mr. Houze was born July 25, 1857 at Marimont, Belgium, the youngest of nine children. Left fatherless in infancy, he was apprenticed to the glassworking trade at the age of 12, and at the time of his emigration to America, 11 years later, he was already an efficient and experienced glass blower. His first employment was with the Day-Williams Window Glass Company in Kent. Ohio, where he soon rose to become boss blower of the entire factory.

Besides being graduated from the school of practical experience, Mr. Houze was the originator of many improvements and methods. He is credited with being the first to use natural gas as a fuel in producing glass, at Olean, N. Y., in 1881; the first to use salt cake instead of soda; the buck-stay bracket; convex shaping formers; another "first" was an oil burner for a railroad engine.

In 1899 he went to Point Marion where he took up his permanent residence except for short periods in the early 1900's, when he left there temporarily to build glass factories. Throughout Mr. Houze's long and active life he designed and built glass factories in many points throughout the United States. At Meadville, Pa., Olean, N. Y., Brownville, Pa., Masontown, Pa., and Salem, W. Va., Lancaster and Fosteria, O.; the Jeannette Window Glass Co., Point Marion; Federated Glass Co., Point Marion and the Houze Window Glass Co., Point Marion.

In 1917 the L. J. Houze Convex Company purchased the Morris Glass Bottle Co., and in 1922 took over the Federated and Houze Window Glass properties, converting them to the production of Houze Convex products.

Leon J. Houze, Sr.

A.C.S. ANNOUNCES TENTATIVE PROGRAM

The American Ceramic Society announces the following tentative list of papers relating to glass that will be read at the annual meeting of the Society, which will be held in Toronto the week of April 7.

Analysis of Selenium in Ruby Glass. *By A. E. Pavlish and R. W. Silverthorn.*

Scratching of Glass by Metals. *By L. G. Ghering and J. C. Turnbull.*

Stresses in Bottles or Jars Due to Difference in Outside and Inside Temperatures (Static Temperature Gradient). *By F. W. Preston.*

Diffusion of Helium Through Several Glasses. *By P. L. Smith and N. W. Taylor.*

Refractive Indices of Various Substances. *By G. W. Morey.*

Bowen and Schairer on System K_2O-Al_2O_3-SiO_2. *By G. W. Morey.*

Refractories Used in Glass Industry. *By R. S. Bradley.*

Durability of Optical Glass. *By F. L. Jones.*

Organization of Glass Research in Colleges and Universities. *By N. W. Taylor and W. Weyl.*

Effect of Time and Temperature on Accelerated Chemical Durability Tests Made on Commercial Glass Bottles (Part II). *By F. R. Bacon and O. G. Burch.*

Melting Rate of Soda-Lime-Silica Glasses as Influenced by Composition, and Effect of Several Minor Constituents on Melting Rate of Such Glasses. *By J. C. Potts.*

Fracture Studies by Direct Photographic Enlargements. *By E. L. Hettinger.*

Reducing Reflection from Glass. *By C. H. Cartwright.*

Advances in Art of Designing Doghouses in Glass Tanks. *By J. E. Frazier.*

X-Ray Study of Potash-Silica Glass. *By J. Biscoe and M. Druesne.*

X-Ray Study of Lime-Borate and Lime-Phosphate Glasses. *By J. Biscoe, A. Pincus, and C. Smith.*

Atomic Consideration of Immiscibility in Glass Systems. *By B. E. Warren and A. Pincus.*

System PbO-B_2O_3-SiO_2. *By R. F. Geller and E. N. Bunting.*

Specific Refraction of Glasses and Glassforming Oxides. *By J. C. Young and A. N. Finn.*

Comparison of Titration and Conductivity Methods for Determining the Relative Solubility of Glass. *By E. H. Hamilton, Donald Hubbard, and A. N. Finn.*

Rapid Methods for Detecting Small Amounts of Coloring Oxides in Some Batch Materials. *By F. W. Glaze and A. N. Finn.*

Effect of Heat Treatment on Dielectric Constant of Some Na_2O-B_2O_3-SiO_2 Glasses. *By J. M. Humphrys and W. R. Morgan.*

Effect of Certain Metallic Oxides on Rate of Heat Penetration of Glass. *By C. W. Parmelee and R. L. Shute.*

Glasses in the Systems Titania-Alumina-Silica and Zirconia-Alumina-Silica. *By A. E. Badger and L. M. Doney.*

Viscous Properties of Soda-Boric Oxide Glasses at Temperatures from 900° to 1500° F. *By B. W. King, Jr., and A. I. Andrews.*

CONCERNING THE MONOPOLY SUIT

By FRANK W. PRESTON

Editor's Note. The suit of the United States Government now pending in Toledo against all the leading members of the Glass Container Industry raises questions involving the whole economic structure of the United States. Opinions differ as to the methods by which the technological progress of industry, and the social betterment of the nation, may proceed. Some want to change by law the whole structure of society, others want to cancel all recent changes in the law. Obviously the best path lies between the two extremes; but just where, is a matter for controversy.

The extension of governmental fields of action is a matter for acute anxiety. It is an axiom of the constitution, well expounded in the Federalist, that Government must have all *necessary* powers to meet any emergency: but it is equally an axiom, laid down by Adam Smith, that Government should not have any *unnecessary* powers, and that its interference in the lives of the citizens should be held down to the very minimum. There is naturally a tendency for government bureaus to hope that the country will live in a state of permanent emergency, as this magnifies their powers and importance. Equally it is the desire of all the rest of the populace that emergencies will be scarce, and the government heard from as seldom as possible. At the same time, it is axiomatic that there are few governments as bad as government by commercial interests.

It would be a great mistake to treat this suit as an incident complete in itself, finished with when the suit is decided. We are in for a long period of investigation to determine where, in a modern complicated democracy, the functions of governments properly end.

As third parties, affected by this suit but taking no part in it, we feel privileged to analyze and comment upon it, and our mission as publishers of THE GLASS INDUSTRY indeed obligates us to do so. Our comment, however, should avoid prejudicing the issues before they are argued in court; nor should it be partisan, and speak for any one interest or group of interests in this complex industry, composed as it is of many and diverse shades of opinion.

In the article that follows, we feel that Dr. Preston has contributed a constructive and penetrating analysis, and that he too has spoken without prejudice or partiality. We welcome the thoughts of other readers who are willing to approach the subject in that attitude.

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In the early days of the present administration, the theory was propounded and backed with some statistics, that the era of intense competition within industry ceased early in the present century, and with it ended the steady decline in the price of manufactured commodities. Through trade associations, and through collaboration between large firms which should normally be cut-throat competitors, there had supervened an era of price stabilization, in which the stockholders reaped the advantages of increasing efficiency in manufacture; whereas under conditions of unrestrained competition, these advantages would have been passed on to the general purchasing public, the general cost of living would have been reduced, the standard of living improved, "real" wages increased, and stock market speculation held within bounds. Under the old system of unlimited competition, it was argued, the benefits of technological improvement in industry would have been more widespread: declining prices would have benefitted the poor farmer, (who represents a substantial part of the American populace), and also the workers in other industries, all of whom represent the "market." Under the system of restricted competition, the beneficiaries of technological advances are confined to the workers of that industry wherein the advance takes place (e. g. automobile factory workers), and the stockholders of such companies.

Some such theory presumably underlies the government's case in the suit at Toledo; for a careful reading of the government's complaint suggests very strongly that what is at stake is not the good name of the Defendants, but a theory of social structure. The glass container industry is on trial, not so much for its sins of commission, but for supposed sins of omission; not so much for its actual misdeeds, as for its failure to assist social progress sufficiently, and along lines believed by the Arnold school to be the best line of progress.

The Bill of Complaint is a very interesting document; so much more interesting than an ordinary Complaint in a civil action that it might be better described as a history of the economic and political development of the glass container industry in this country. If it were not serving as the basis of a lawsuit, and if the allegations as to the motives were omitted as necessarily speculative, the document would of itself be a well-written and highly entertaining account of how the container industry came to take on its present complexion. Moreover, since much of what is therein printed has already been ventilated in the TNEC meetings at Washington a year ago, its seems likely enough that the history is substantially correct as far as it goes. Except for one thing. The container industry was not asked to present its side of the case at the TNEC hearings, and no one can say in what manner this testimony might have altered the picture. We think the writer of the Bill of Complaint should be congratulated on making it so interesting.

At the same time, it must always be remembered that what can be written is only a minute fraction of all that actually occurred; the circumstances were in all cases vastly more complicated than the simple story the government has set down; and so far as motives are concerned business men are mere human beings, and are constitutionally unequal to the steady sustained calculating malevolence imputed to them. Their own fears and anxieties, their perplexities and misgivings, their prospects of financial loss or even complete ruin, do not figure in this story. Only their sublety, their readiness to take unfair advantages, their willingness to cheat, lie,

spy and deceive, their selfishness and their success is set forth. The other side of the story, the struggle of impecunious and sometimes bankrupt inventors, has yet to be heard. It is to be hoped they can make it as entertaining as the Government's history. A fair and interesting presentation of both sides is much to be desired, and it did not take place at Washington.

The industry will do well to recognize that the government is not necessarily wrong in its attitude. The Government had a quarrel with the Stock Exchange, and some of its allegations were well founded. Again, we owe it to the Government, and not to a famous firm of chartered accountants, that the McKesson & Robbins scandal was uncovered.

The Government, however, is not always right, nor is it always unprejudiced and dispassionate; for government bureaus, like businesses, are run by human beings of limited intelligence and limited ability to avoid bias. And the point of these last two paragraphs is, that the forthcoming lawsuit is neither a calamity nor an insult; but, properly handled, is an excellent opportunity to publicise the good features of the industry and to correct or improve the others.

It may be possible, from time to time, to take some of the Government's charges, and perhaps some of the contentions of the defense, and analyze them according to our own views and knowledge, but obviously it is of the greatest importance to avoid idle comment that might interfere with the proper course of the suit. On most points the parties to the suit have more complete information than we have, and our comments and analysis would be beside the point. We do think, however, that we are entitled to discuss the background of the suit, the varying concepts of the social structure that we desire, end even our concepts of what the actual social structure of the present, and immediate past, has been.

We mentioned at the beginning the view some have held, that a distinct change in social structure started about the first or second decade of the century, whereby competition became less vigorous, and benefits were not passed on to the whole body of the public in adequate price reductions. The Government's attitude at present seems to be that this phenomenon had no relation to any natural causes, but originated solely in the greed of the wealthy, and in their unscrupulous exploitation of their powers.

This is not going to be easy to disprove, and it will certainly not be disproved, for the general case, by this lawsuit. But several other things happened about the same two decades that would have had a profound influence on social structure, and very likely on price structure, and on equality or inequality of incomes, quite apart from calculating malevolence on the part of malefactors of great wealth.

To begin with, the frontier disappeared; immigration was cut off; family limitation became general; sanitation, medical knowledge, and medical services greatly increased. All this means that instead of an empty land into which a rapidly increasing population was erupting lawlessly, with a high birth rate, a high death rate, a rapid renewal of the population and a change in its ethnic character, we were becoming an occupied territory, of older people, of more nearly fixed ethnology, and less subject to mass migrations. The change is necessarily from radicalism to conservatism, from lawlessness to order, from a rejoicing in strife and competition to a desire for security and collaboration.

This underlying change of social structure has to be allowed for, and both parties to the dispute ought to recognize it. Probably they do recognize it, and the real question is a difference of opinion as to what is to be done about it. Both parties are appealing to the past—the Government to the Sherman and Clayton acts, which belong to an earlier era, and the defendants to the Constitution of the United States, which is even earlier.

Along with the social changes of the decades mentioned, there were technological changes that had profound social repercussions. Perhaps the most conspicuous was the coming of mass production. Now mass production is not simply producing things in masses, in greater quantity than hitherto; it is a special technique, a new method of operating, and it cannot be handled by multiplying the pre-existing facilities. It needs entirely new facilities. The public thinks of mass production in terms of the automobile industry, which did not exist prior to this century; but the glass container industry is mass-productive, and became mass-productive early in the century, when the Owen's suction machine and the Hartford, Empire, Howard and Tucker & Reeves feeders were invented. As these things spread over the country, handicrafts faded before them, and the Glass Container industry, as we envisage it, dates from that time. But whereas there was no automobile industry to speak of till the coming of mass production, and the automobile merely displaced the horse, with which the Department of Justice is not concerned, there was a bottle industry long before Owens, Peiler or Howard, and a number of firms that did not disappear like the horses, but adapted themselves with varying degrees of success to the new regime.

Not all of these companies developed suction machines or feeders. Many who did not were helped—at a price—by those who did. Most of them felt that the price should have been less. Many of them felt that they were willing to pay for new machines, and ought to be able to buy any machine at, say, ten cents a pound. The inventors and their backers had different ideas, and the patent laws were intended to encourage them in these ideas. Unfortunately, the patent laws are rarely of any use unless the inventor has lots of money to make use of them, and it happened in the glass container industry that some of the inventors, or their backers, had money. These inventors were more fortunate financially than the man who was the first to come to the fundamental realization that to make bottles by machine, two molds would be necessary, a blank as well as a blow. This basic "discovery" was rewarded by a very few dollars indeed, which is the normal lot of inventors. But the inventors of the suction and feeder devices, whose superior methods for getting glass into the blank mold so vastly revolutionized the container industry as to virtually re-create it, obtained a very large measure of control over the industry by collaboration and by a series of intelligent moves.

There is at present some $150,000,000 worth of business per annum in the glass container industry, and while this is small compared with say steel, the sum is

large enough to cause a willingness to fight over it. The inventors did a good deal of fighting with one another at the start, until their more far-sighted supporters saw that much more was to be made by collaboration than by conflict. The Government contends that the collaboration was illegal, that it was a conspiracy, that they ought to have gone on conflicting. Then they would have destroyed one another, and the industry would have obtained its machines at ten cents per pound. Further, the Government supposes that many more firms would have entered the glass container field, and prices of bottles and jars would have fallen to substantially lower levels, to the benefit of the general public.

The answer to this is, of course, that inventors who have been starved to death will not continue to make inventions for the benefit of the general public. Further if the results are to be not merely problematical, but definitely non-existent, they will not be able to obtain financial backing for their work. If, however, a man can invent, as it were, a whole new industry, he has a moral right to a large profit, and as a matter of political expediency, it is necessary to concede this right, so that he can obtain the essential backing. These things are so, and they remain true even if to ignore them would momentarily produce a lowering of price to the general public. For by skinning the inventors and their backers, the public would be merely killing a goose that lays golden eggs. There won't be any more golden eggs after all the inventors have been skinned or threatened with skinning.

The container industry has exercised a steady pressure on its members to observe certain standards of quality and collaboration. It is probable that some part of the effectiveness of this pressure is due to the patent situation. But this operates in the public interest, for insofar as the pressure is effective the public is assured of bottles that do not constitute a public menace. I have reason to believe that in proportion to their numbers, imported bottles have been much more of a risk to the user than domestic ones.

To quote John Ruskin; "There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper; and the people who consider price only are this man's lawful prey." What John Ruskin did not foresee, was that a government department might become too concerned with price only, and might insist on things being made a little worse and sold a little cheaper; and that the sufferers would not be the government department, who are not purchasers, but the general public. No doubt the Department of Justice has considered this point, and figures that it will first prosecute the industry for not selling cheaply enough, and after a little more cheapness has been attained, it will then prosecute the industry for not manufacturing well enough.

The Defendants, we presume, will take the position they wanted to take at Washington, D. C., and endorsed in a recent statement by Senator King of Utah, a member of the T.N.E.C. committee, viz. that the industry in question has been very distinctly a social asset, and in some ways a model industry. It has, for instance, maintained a remarkably steady level of employment throughout the depression, a thing scarcely any other old-established industry has done. It has neither strikes nor lockouts. Wages have been increased steadily, when every other industry was turning its men loose on the W.P.A. Hours of work have gone down, and in spite of all this, the price of bottles has gone down too, and that steadily for ten years past. Those of us who are interested in the technical aspects know, by and large, that there has been a remarkable concurrent improvement in the quality of the bottles, and that this has been achieved not solely through the efforts of the individual companies, but largely throught their collaborative efforts as a Glass Container Association.

The public is getting steadily better bottles at a steadily declining price. The workmen are getting steadily increasing wages for less hours of work, and remarkably steady employment compared with other industries. The inventors, some of them, are still alive, and some that died did not die in poverty. A lot of small companies have survived and make a profit in spite of royalties.

The vendors of beverages would like bottles still cheaper; the workmen would like still higher wages, and the inventors would like higher revenues. The bottle manufacturers would like to pay no royalties. Entrepreneurs with no experience of glass manufacturing would like to start bottle factories all over the country and participate in profits at the present level or higher. But when all had compromised their divergent ambitions, maybe the state of affairs would be something like what it is now. A quarrelsome, mutually suspicious lot, competing enough to keep everybody on their toes, but collaborating against other industries, like the Scots who fought each other all the time, but combined whenever the English came over the border.

It may be taken as axiomatic that it is far more important to combine against undue interference from the government, with its unlimited powers, than it is to combine against manufacturers of tin cans or paper containers, where the fight is with an adversary of limited strength. This is not to say that we are calling for a united front against the Department of Justice in this lawsuit; on the contrary, we think this is a good opportunity to bring out all the facts; but an industry as well managed as this has been (compared for instance with the wire glass industry) ought to unite in presenting the facts to the public, and in maintaining its right to self-government, unless a clear case of *undue* restraint of trade and competition can be proved.

To quote A. T. Mason[1] "It was settled in the Standard Oil[2] and American Tobacco[6] Cases that only *unreasonable* restraints of trade are forbidden by the Sherman Act. But this statute set up no standard of reasonableness. The judges must supply one."

It would seem to follow that the courts of Toledo will have to decide whether the Glass Container Association and the Hartford Empire Co. have acted *unreasonably*, and the decision will depend very largely on the views of the courts as to what is the social structure we desire, and whether the net effect of the various actions complained of, has been to the public advantage or not.

This will involve an intensive contemplation of two sets of conditions, one the actual state of (social) affairs produced by the course adopted by defendants over the last two decades, and the other the probable consequences that would have been produced if Thurman Arnold had been running the industry, or if it had been run accord-

ing to his philosophy, which is quite generally known.

The former is easily ascertainable, as being a matter of history and available statistics: the latter is a matter for speculation, or for estimate.

Some of our estimates would be:

In the absence of any restrain of competition, and in the absence of any technical information from patent-holding companies or leading manufacturers, prices would probably have fallen to a point where all the weaker and smaller companies would have gone out of business. This has actually happened in the wire glass, plate glass and window glass businesses. There only two or three companies survive in each line.

Free competition cannot be maintained between two or three large companies as readily as between twenty or thirty of assorted sizes, and there would be less incentive to make further improvements in quality, or to continue reductions in price. (The window glass business has not been nearly so progressive as the container industry). However, the controlling factor here might still be the competition of other industries, and in that case the public would neither gain nor lose very much, whichever theory is adopted.

Next there is some reason to suppose that these larger companies will tend to become international in scope. The plate glass companies are either owned by foreign interests, or own foreign plants, so as to keep in touch with European developments. In the wire glass industry, one of the large concerns is dominated by foreign interests. In the window glass industry, to some appreciable extent technological advances await developments abroad. This is entirely different from the situation in the container field, where American industry is unequivocally the leader. Whether this is an advantage to the general public, except as a matter of pride, is of course a moot point.

With profits (presumably) cut to a minimum in order to reduce prices to the public, with no royalties to pay (a thing that would not affect prices very much anyway), and the business concentrated in two or three mass-production plants, there would be no incentive for newcomers to try to get into the business, and little prospect of their making a success of it if they did try. There have been no new companies successfully entering the automobile industry of late, and no new entrants to the plate glass, wire glass, or window glass field, except foreign concerns who admit frankly that the question of profit does not concern them so much as questions of politics.

Thus on the face of things, competition arranged by the government might prove entirely unstable, and tend to eliminate itself much faster than happens at present.

An ideal situation cannot be obtained by doctrinaire methods, and a careful study of a large number of industries and their history is called for. Into some industries, like catering and gas-filling stations, new-comers pour in floods, and mostly go broke. The public presumably gets its service at the cheapest, but it is not an ideal social phenomenon, and most of us would prefer cleaner restaurants and filling stations and less competition. There have been careful studies of many of these social phenomena, and it is to be hoped that the courts will be sufficiently familiar with all of them to decide wisely how far the practices of the container industry have been in the ultimate public interest, and how far they should be modified.

[1]Alpheus T. Mason, "Brandeis," Princeton University Press, 1936.
[2]Standard Oil Co. v. United States, 221 U.S.1 (1911).
[3]United States v. American Tobacco Co., 221 U.S.106 (1911).

BAUSCH & LOMB ANNOUNCES LENSES WITH METALLIC FLUORIDE COATINGS

The first commercial application of monomolecular films of metallic fluorides to projector lenses has been announced by the Bausch & Lomb Optical Co. As a result of tests made in Rochester moving picture theatres, where it was found that screen illumination could be stepped up from 15 to 30 per cent, Loew's Theatres recently ordered the new lense equipment for 25 theatres for the premier showing of "Gone with the Wind." By means of the new equipment, image contrast was improved and focus sharpened, and the screen brilliance attained no doubt contributed to the tremendous popularity of the production.

All will recall the announcement last year that came simultaneously from the laboratories of General Electric Co. and Massachusetts Institute of Technology of the monomolecular film discovery, by which the transmission of light through a lens is increased by reducing reflection. Dr. Blodgett made use of films of fatty acids; Dr. Cartwright used metallic fluoride films.

The metallic fluorides, however, are much tougher films than the fatty acid types. In the long series of investigations conducted by Dr. W. B. Rayton in the Bausch & Lomb laboratories, it was evident that a combination of two processes could be used to greatest advantages. On lenses having an exposed outer surface, a corrosive chemical process is used in which oxides of high refractive index are removed from the surface leaving an invisible structure of silica, while the inner glass-air surfaces are coated by the deposition of a metallic fluoride in a high vacuum.

In both processes the coating is held to a thickness of a quarter wavelength of light, or about four-millionths of an inch. The film must be intermediate in refractive index between air and glass. Since both the film and the lens surface reflect light, it is necessary that the crests of the waves from one beam shall fall into the troughs of the other; thus being out of phase the waves neutralize each other and reflection is decreased or entirely eliminated. The missing radiation re-appears in the transmitted beam which has been shown to contain as much as 99.6 per cent of the original radiation.

From four to six per cent of the incident light is lost at each glass-air surface of a lens, the precise amount depending upon the type of glass used and the color of the light. A crown glassair surface reflects about 4 per cent of the light, whereas flint reflects 6 per cent. It will readily be seen that in a lense with a number of elements, or in optical instruments with complex systems of optical parts, light transmission can be increased tremendously. Equally important is the reduction of halo and the improvement in image contrast.

The new coating processes are at present being confined to a limited number of products but the progress so far attained promises a great step forward in optics.

M. I. T. RECREATES SANDWICH GLASS CO.

The Boston and Sandwich Glass Company factory is again glowing—in miniature. After a year of painstaking research, the Massachusetts Institute of Technology has completed what is believed to be a true replica of a typical glass factory of that day, and the model is now on exhibition in its museum.

The task of reconstructing a genuine old New England glass house has been beset with difficulties from the start; for while many details could have been compromised, those engaged in the work of reconstruction were striving for faithfulness and accuracy in every detail. Fifty-two years have elapsed since Sandwich closed its doors for the last time. Most of the data relating to the company; as for example, the notes bequeathed to the Institute by Thomas Gaffield, relate to the glass and not to the factory proper. There are still a few men living who worked in the factory in its latter days; but it was found their memories were confused and conflicting. So, countless sources had to be painstakingly examined, and fragments of material extracted and pieced together before a complete picture was possible.

The factory reproduction is built on a scale of one inch to the foot and is about seven and one-half feet long. The figures range from five to six inches in height and are in color. Illusion of flame in the furnaces is obtained by use of small electric light bulbs. The tiny goblets which are shown being removed from the annealing oven by an apprentice boy, presented another problem, until the Corning Glass Works agreed to make them. The model is most complete, even to the scenery seen

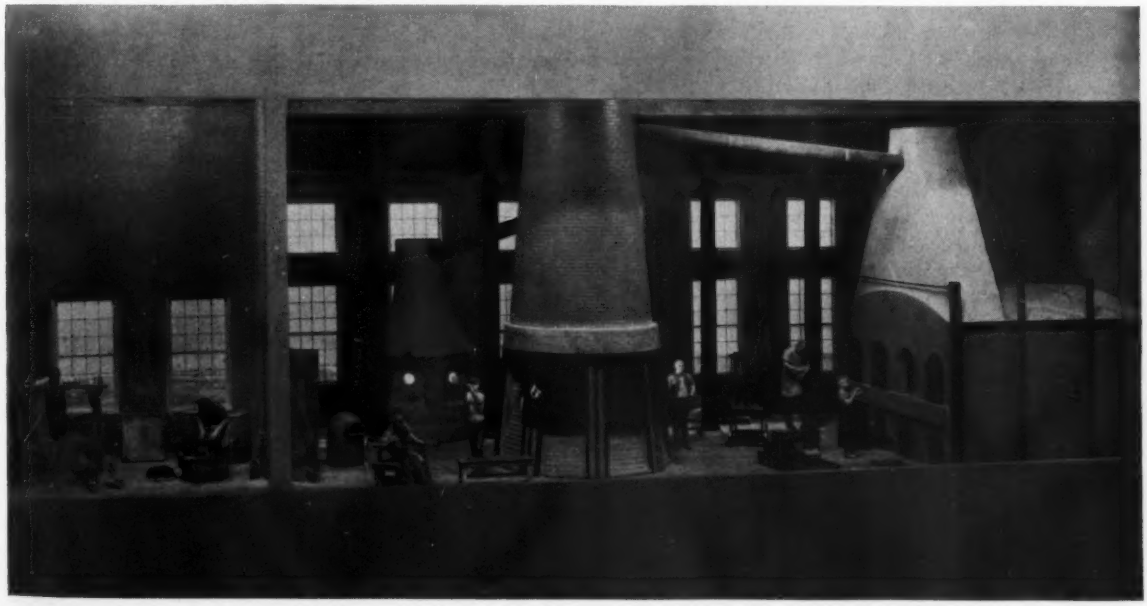
Supervision of the model building was under the direction of Arthur C. Watson. For consultant and technical advisor, Prof. F. H. Norton, head of the ceramics department, filled the role. W. T. Farwell, Jr. had direction of the field work.

OPTICAL SOCIETY TO MEET

A joint meeting of the Optical Society of America, the American Physical Society and the Inter-Society Color Council will be held in New York City, February 21 to 24. Sessions of the participating societies will be held simultaneously and at each, papers will be read on a variety of subjects. A symposium on "Optical Methods for the Study of Molecular Structure" will be presented at a joint session and the three organizations will meet for dinner on Friday evening.

SOC. OF GLASS TECHNOLOGY MEETS

At the last General Meeting of the Society of Glass Technology, held in Sheffield, England, on November 22, papers were presented covering the following subjects: "Glasses: Organic and Inorganic," by Harry Moore, Director of Research, Pilkington Brothers, Ltd; "An X-Ray Study of Natural and Artificial Mullites," by H. P. Rooksby and J. H. Partridge, Research Laboratories of the General Electric Co., Ltd., "Devitrication in Tank Furnaces: A Preliminary Note," by R. Halle and Professor W. E. S. Turner.



This model of a mid-Nineteenth Century glassworks, based upon the famous Sandwich Glass Factory, was built in the Hobby Shop of the Massachusetts Institute of Technology under the Institute's Museum Committee. Apparatus and processes are accurately represented. At the left a man treads clay for use in making fire pots such as that upon which the next worker is engaged. In the main body of the factory, a team of men is at work, one man blowing glass lamp bowls which are finished by his partner, who is seated in the glassmaker's chair. Beyond the furnace stands the gaffer, or boss, near a glass press. Nearer the annealing oven at the right, a worker is blowing glass into a foot-operated mold. The apprentice boy is placing finished ware in the annealing oven.

INVENTIONS AND INVENTORS

Summary of United States patents of interest to the glass industry issued during December

Raw Materials

Rob Roy McGregor, a Senior Fellow at Mellon Institute received patent 2,182,384 for a useable product derived from the waste sand obtained in the grinding and polishing of plate glass. The patent details and claims the method of refining this previously wasted material. A typical composition of the discarded sand is reported:

	Per cent
Sand grains	70 to 85
Glass debris	15 to 25
Gypsum from plaster of paris	0.3 to 7
Rouge	0.2 to 0.5
Metallic iron	1 to 1.5

By acid treatment to remove rouge and lime, magnetic treatment to remove iron, and by other means, a finely divided glass and silica mixture having many uses is obtained. This product, sold as "Garspar," is now in commercial production and is sold as glass batch material to replace flint and cullet. Other uses include the replacement of flint, feldspar, talc, and auxiliary fluxes in ceramic bodies. The McGregor patent was assigned to Norbert S. Garbisch who sponsors the Mellon Institute fellowship (headed by Dr. George J. Bair) which is developing these products.

Feeding, Forming and Shaping

George H. Snyder assigned patent 2,184,900 to Corning Glass Works. This is a light bulb machine of the Woods type patented in 1931 (U. S. Patent 1,790,397), which gives increased production due to changes made principally in the blow-box and blow-head assemblies. These details cannot be fully discussed in this space.

Hellmuth Fischer of Ilmenau, Germany obtained a patent, 2,183,961, on a method of combining two or more types of glass to produce a stratified glass tube.

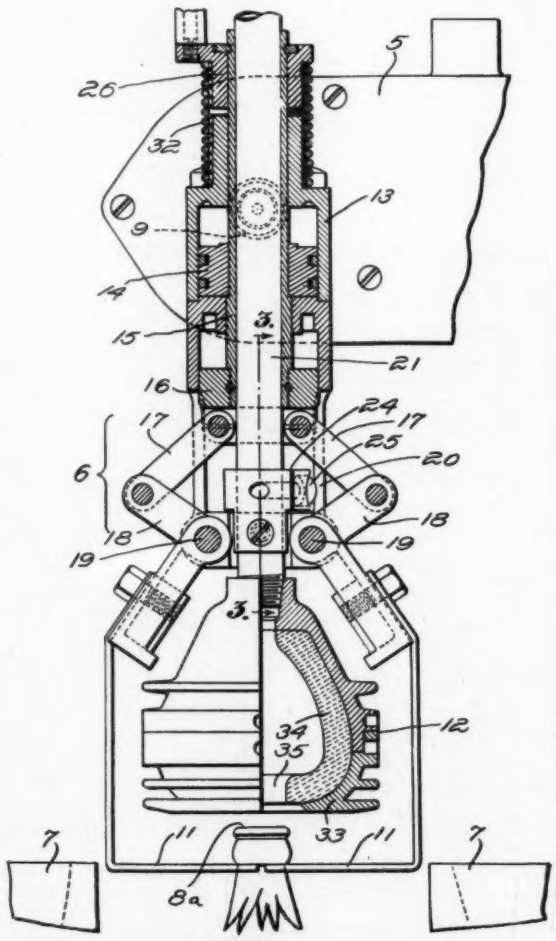
Two patents on diverse subjects were granted to Walter K. Berthold, Rockville, Conn., who assigned them to Hartford-Empire Co. Patent 2,182,166 is a glassware take-out and fire-finishing device (similar to that shown in Henry W. Ingle's patent 1,843,285 granted in 1932), and 2,182,167 represents a ware cooling device for the Hartford I. S. machine. The first patent provides a novel unit for removing bottles from the molds of a forming machine, and for fire-finishing them during removal. As illustrated herewith, tongs 11, actuated by compressed air, are lowered and closed around the bottle neck, while gas is supplied to burner 12, to provide a flame for fire-finishing the bottle top. At all other times, a small flame is maintained. The burner is bulbous in form and comprises a metal casing 33, with a refractory lining 34. The burner opening is indicated by 35.

The cooling device of Berthold's patent 2,182,167 is intended to stiffen glassware such as fruit jars, by cooling the outside surface after release from the mold. In the accompanying illustration, a newly formed jar 25 rests on the dead plate 12 of a forming machine section. This Berthold invention provides for air to be driven upward through holes in the bottom of the dead plate into the housing 26, which confines and directs the air against the jar. The housing 26 then sinks out of the way, so the jar can be moved to the adjacent conveyor 13.

Decoration

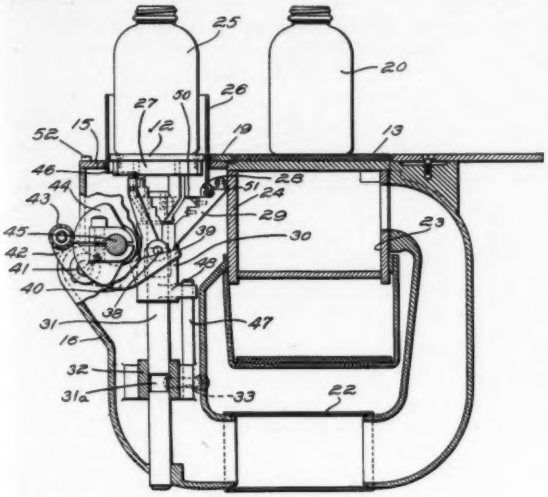
A tumbler decorating apparatus (2,183,230) was assigned by J. H. Treece, H. L. Whitney, and H. W. Schneider to Libbey Glass Co. The apparatus applies a glue-type sizing material to tumblers, bottles, etc., so that they may subsequently be dusted with suitable vitreous enamel powder. The machine provides a reciprocating pad to which the sizing material is repeatedly applied. Novel features include means for bracing the glass ware against shifting.

A stenciling apparatus for curved surfaces was assigned by Lawrence O. Mankin and Leonard D. Soubier to Owens-Illinois (2,183,223). In the decorating zone of their machine, means are provided for a squeegee, a reciprocating stencil screen, and for continuously moving the ware through the zone while the decorating units are moved bodily in relation to the ware.



2,182,166: Berthold, Hartford-Empire Co. Glassware take-out and fire-finishing device.

2,182,167: Berthold, Hartford-Empire Co. To stiffen a newly-formed jar, cooling takes place inside a casing 26, which is lowered when the jar is ready to move to the conveyor.



Miscellaneous Processes

A Hartford-Empire patent granted in December, was 2,182,173 to Francis E. Dorsey, for an improved firebox construction in an annealing lehr.

George A. Philippe of Henryetta, Oklahoma, patented a glass cutting machine (2,184,126) for making several cuts simultaneously when cutting a sheet into strips.

Andre Do Huu Chan of Sceaux, France, assigned to Societe Anonyme des Manufactures des Glaces & Produits Chimiques de Saint-Gobain, his patent 2,184,908 for devices for regulating the temperature of metal cylinders and rolls used in various processes throughout the glass plant. To overcome certain disadvantages of cooling rolls by air blast or water circulation, Chan regulates their temperature by means of brushes or similar metallic elements applied against their surface, and through which heat can be supplied or removed. Reproduced herewith are Figs. 5 and 8b which show respectively the use of the Chan brushes for cooling and heating rolls. Figure 5 shows the brushes being cooled by water circulation 29, and by contact with a water cooling case 30, so that they may take heat away from rolls used for forming a sheet of glass. In figure 8b a burner at 48b heats the brushes; they in turn heat roll 45b. Broad claims were allowed.

Patent 2,184,915 was granted to David E. Gray of Corning Glass for improvements in conveyor mechanisms.

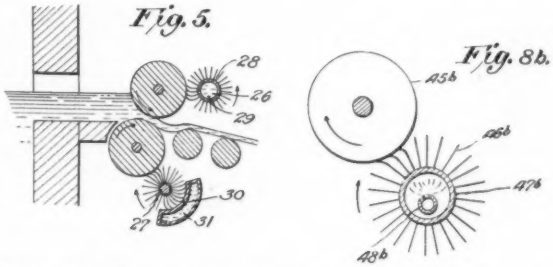
Fibers

Five patents covering uses and treatment of gloss fiber were assigned to Owens-Corning Fiberglas Corporation: 2,184,326 to John H. Thomas for automobile tires containing fabric woven from glass fibers; 2,184,899 to Errol B. Shand, for burner wicks of glass wool fabric coated with a layer of organic material; 2,184,286 to Howard W. Collins for a package of glass wool bats marked in a manner to facilitate separation of the package into individual bats; 2,184,316 to Jesse H. Plummer for a fiber binding composition; and 2,184,320 to Donald C. Simpson for a means of treating glass fibers to overcome the effects of alkalies leaching to the surface.

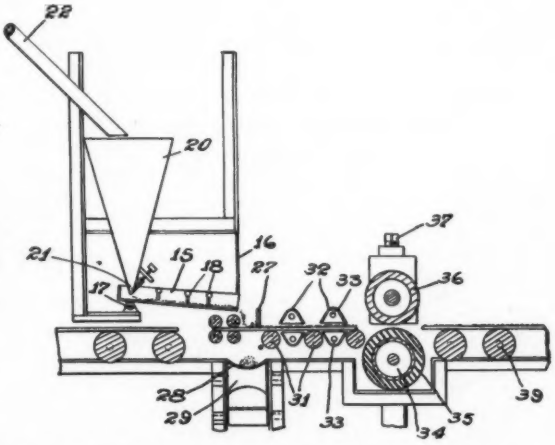
Plates and Sheets

James H. Sherts and Brook J. Dennison of Tarentum, Pa.(Pittsburgh Plate Glass Co.) were granted a patent (2,182,358) on an apparatus for making safety glass, which represents a division of another application which issued as patent 2,106,766 on Feb. 1, 1938. The primary object is the provision of apparatus which enables a finely powdered plasticized resin to be incorporated directly into a laminated glass without the use of a solvent, or the necessity of preforming the resin into sheets. The apparatus is detailed in claim 1 as "means for feeding a layer of finely divided plasticized resin onto the plates as they move along the conveyor, means for heating the plates and the resin layer thereon to cause the resin particles to adhere to each other and to the plates, presser means above the line of travel of the conveyor for compacting and smoothing the layers of resin on the plates, and heating and pressing means along the further line of travel of the conveyor which heat the plates and press them after they have been assembled with the resin layers there between."

A portion of the Sherts-Dennison apparatus is illustrated in the figure reproduced herewith. The powdered resin is made to flow by vibrating means to a glass sheet, and is smoothed out by a scraper 27, which also controls its thickness. Heating elements in reflectors 32 soften the resin and cause it to adhere to the plate, and the roll 36 applies soft pressure to give the resin layer greater evenness. (*Continued on page* 81)



2,184,908: Chan, Societe Anonyme de Saint Gobain. Utilizing brush-like devices to heat or cool rollers in glass machines.



2,182,358: Sherts and Dennison, Pittsburgh Plate Glass Co. Method for making laminated safety glass by applying the resin in powdered form.

THE GLASS INDUSTRIES IN DECEMBER

According to GLASS INDUSTRY's Production Index, December's output of glassware was valued at $29,500-000 which, while slightly below the previous month, exceeded December of 1938 by over twenty per cent. This was the highest December production on record.

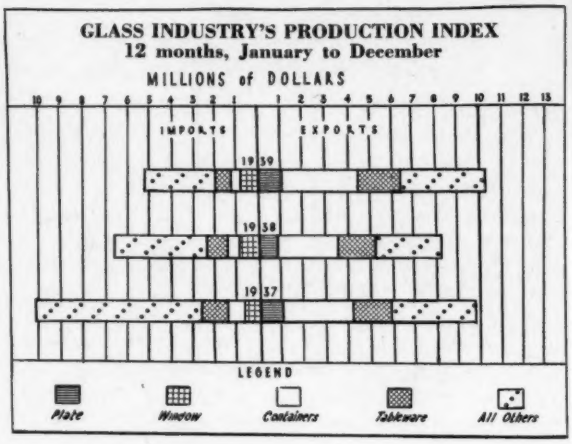
The Index also reveals that 1939 was the most active year in the history of the industry with the exception of 1937. It is estimated that production of glass and glass products increased almost thirty per cent over 1938 to $320,000,000 (about ten per cent less than 1937's record figure). All branches of the industry shared in the increased business.

Plate Glass output during December totalled 18,-477,000 square feet according to the monthly report of the Plate Glass Manufacturers of America. Establishing a contra-seasonal trend, this volume represented an increase of sixteen per cent over the previous month and was forty-six per cent over December 1938. More plate glass was produced during the month under review than in any comparable period since June 1937.

Final compilations of 1939's production reveal a net total of 141,741,000 square feet,—sixty-five per cent greater than during the previous year. An analysis of statistics for past years reveals that 1936 set a record for the plate glass industry with a total production of 198,069,000 square feet; 1937 ranked second with 192,-592,000 square feet; 1935 third with 180,384,000 square feet and 1939 fourth with 150,244,000 square feet. 1939 thus assumes fifth place.

Window Glass production during December amounted to 1,189,000 boxes according to the Window Glass Manufacturers Association. This was four per cent above November's level and nineteen per cent more than the same month last year. December's operations were at a higher rate than any month's since November 1937.

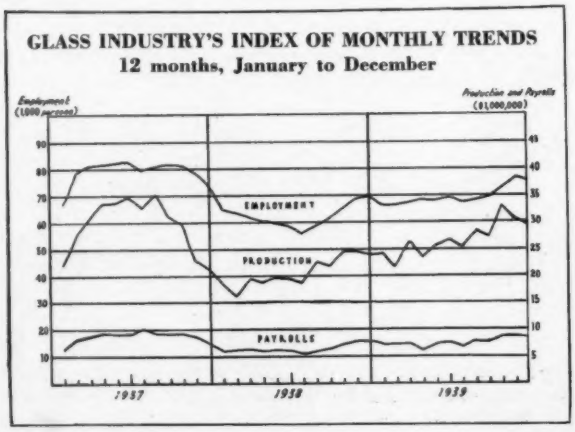
1939 proved a highly satisfactory year to the window glass industry, with output recorded at 10,776,000 boxes. Surpassing 1938 by sixty-three per cent, this total represents the largest annual production in history with the exception of 1937, and during the last quarter this activity was forty-six per cent above even that year's comparable period.

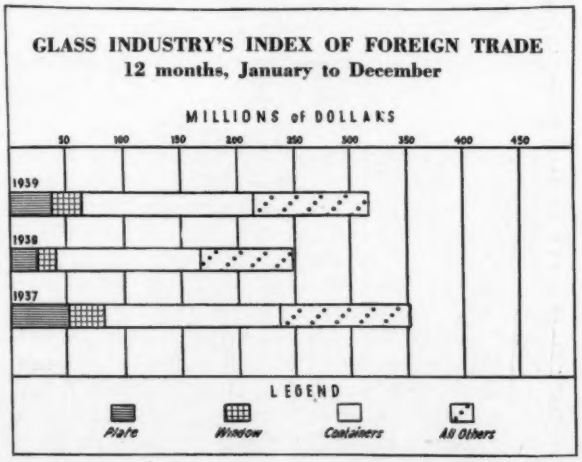


Glass Containers manufactured during December totalled 4,046,000 gross, according to the Glass Container Association of America. While this was a decline of six per cent from the previous month, it represents the highest December output on record. Although shipments dropped twenty per cent, they too surpassed all previous December figures.

This year-end upward surge brought twelve month totals close to 1937's peak; but after the final bottle had been counted, 1939's production stood at 51,224,555 gross—just 2.7 per cent short of a new record. A net gain of nineteen per cent was registered over 1938's production but shipments increased only fourteen per cent to 49,167,000 gross. As a result, stocks on hand at the begining of 1940 amounted to 9,237,000 gross, the largest since March 1938. Adjustment of this comparatively high inventory position was one of the problems facing the industry during January.

Miscellaneous glass products produced during December were valued at about $9,500,000 according to reliable estimates. This figure was five per cent below





November's totals, but comparisons with December of the preceding year indicate an increase of over twenty per cent. Illuminating ware operations, experiencing the usual seasonal decline, nevertheless kept within ten per cent of the previous month's activity. Tableware producers continued close to capacity production up to and including the holiday period—a highly contra-seasonal trend. Another branch which had an extremely active month were the manufacturers of technical and scientific wares.

Preliminary estimates covering the twelve months of 1939 place the production of the miscellaneous glass group at about $100,000,000 or twenty-five per cent above 1938. Statistics indicate that this activity was within fifteen per cent of 1937. On a year to year basis, tableware output was about ten per cent above 1938 but below 1937 by about the same percentage. Production of illuminating ware was almost twenty per cent greater in 1939 than in the previous year, but did not equal 1937.

Employment and Payrolls. Approximately 76,000 workers were employed in the glass industry during December as compared to 77,000 in November, and with 69,000 in December 1938. Available statistics indicate that employment during the month under review was greater than in any previous December.

The average of employment in the glass industry during 1939 is estimated at 70,000 persons which was a net gain of 6,000 over 1938. This compares with 79,000 in 1937 and 68,000 in 1929.

The glass industry payroll during December is placed at $8,700,000—slightly below the November level, but about $1,000,000 more than in the comparable month of 1938. Here again a new December record was established.

During the twelve months of 1939, glass manufacturers paid over $91,000,000 to their workers, an increase of almost $15,000,000 over 1938. With the exception of 1937, this was the largest payroll in the history of the industry. 1937's total was $102,000,000 while 1929's was less than $88,000,000.

Foreign Trade in glassware during December was valued at $1,400,000—about 17 per cent less than the previous month, but slightly more than the comparable total for 1938. Exports during December were 1 per cent below November, but 29 per cent above the previous December; on the other hand, imports were 51 per cent under November and 41 per cent below December of 1938. All types of glass were exported in larger quantities during December, with the exception of plate glass which accounted for the slight decline in total volume. Almost the reverse was true of imports, since all types of glass were imported in smaller quantities.

Preliminary statistics covering the full year of 1939 indicate that exports were valued at almost $10,500,000—a 25 per cent increase over 1938. This was the highest export figure in a decade.

On a percentage basis largest gains were noted in flat glass products, while actual volume increases were greatest in containers, tableware and miscellaneous pressed and blown items.

Imports of glass and glass products during 1939 dropped 41 per cent below 1938 to $5,158,000. Container imports were down 43 per cent while foreign purchases of illuminating ware dropped 38 per cent, and plate glass 35 per cent. Sales of foreign made tableware were placed at $873,000 as compared to $994,000 in 1938 and $1,368,000 in 1937.

RECENT EXPORT TRADE OPPORTUNITIES

Below is a list of recent inquiries received at the Specialties Division, Bureau of Foreign and Domestic Commerce. Those interested should write immediately to H. B. McCoy, chief of the Division, or to any of the Bureau's District or Cooperative offices, specifying the reference numbers of any inquiries they wish to contact.

Reference Number	*Commodity*	*City and Country*	*Purchase or Agency*
5545	Bottles	Manila, P. I.	Agency
5666	Bottles, Containers and laboratory tubes	Cali, Colombia	Agency
5596	Bottles, lotion and perfume	Singapore	Both
5624	Bottles, soda-water, beer and milk	Alexandria, Egypt	Agency
5549	Bottles and jars for cosmetics	Mexico City	Agency
5666	Glass, plain	Cali, Colombia	Agency
5547	Glass, pressed	Rio de Janeiro	Agency

UNITED STATES FOREIGN TRADE IN GLASS

(Values in Thousands of Dollars)

	1939			*1938*		*Percentage Change*		
	November	*December*	*Twelve Months*	*December*	*Twelve Months*	*Nov.-Dec.*	*Dec.-Dec.*	*Twelve Months*
EXPORTS								
Plate	122	102	1106	94	792	— 16	+ 9	+40
Window	10	20	70	3	36	+100	+566	+94
Containers	348	350	3454	292	2897	+ 1	+ 20	+19
Tableware	198	204	1963	153	1578	+ 3	+ 33	+24
Illuminating Ware	42	59	473	34	405	+ 17	+ 74	+17
All Other	352	327	3395	248	2624	— 6	+ 32	+29
Total	1072	1062	10461	824	8332	— 1	+ 29	+13
IMPORTS								
Plate	12	5	75	10	115	— 58	— 50	—35
Window	63	27	793	130	834	— 53	— 89	— 5
Containers	30	14	324	39	566	— 53	— 64	—43
Tableware	63	61	873	63	994	— 3	— 3	—12
Illuminating Ware	23	14	375	53	609	— 39	— 74	—38
All Other	436	186	2718	230	3410	— 57	— 19	—20
Total	627	307	5158	525	6528	— 51	— 4	—21

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	45.00	51.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027-.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054-.0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07⅛
Cryolite ($Na_3Al F_6$) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00-31.00	....
In bags	ton	31.60-32.60	42.00-45.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.08	....
In 5 Ton lots	lb.	....	.08½
Less than 5 Tons	lb.	....	.09
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	8.50	8.50
Burnt (CaO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.00-14.00	....
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00-20.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.029	.03½
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	No supplies available.	
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05¾-.06	.06¼-.06½
Tin Oxide (SnO_2) in bbls	lb.	....	.52
Titanium Oxide (ceramic grade)			
In bags	lb.	.12	.12¼-.12¾
In barrels	lb.	.12¼	.12½-.13
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls	lb.	.08¼	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.00
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	40.00	44.50
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_2O_3)			
In bbls	350 lbs. or more, lb.	....	1.84
	Less than 350 lbs., lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.165
Black (CuO)	lb.	....	.18-.19
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425-.09
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls	lb.	....	.135
Manganese, Black Oxide			
In Paper bags	ton	62.50	65.50
In Burlap bags	ton	64.25	67.25
In Casks	ton	66.50	69.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09¼-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.19-.24
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08¾-.08¾
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65.
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.75-1.80
Yellow	lb.	....	1.75-1.80
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.65-2.75
Yellow orange	lb.	....	1.75-1.80

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, 1½, 1.	lb.	....	.04
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	....	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

That Fourth Man!

One of the most exciting and popular races to see is the four man mile relay. That fourth man has a big job to do. If he is given the lead, he must hold it; if he hasn't the lead, he must go out and try to get it. This requires plenty of speed so he can drive through to a winning finish.

Three men might run a mile relay, but it won't be run as fast as a four man team, nor as consistently good . . . . There is a parallel in the manufacture of glass. Here only three ingredients are actually needed: soda, lime and silica, but an increasing number of manufacturers prefer to add a fourth ingredient, Borax, as a constituent of the batch, for it brings about speedier and better melting, besides greatly assisting in the refining process.

As a result, the finished article has enhanced appearance as regards both color and lustre, while it is mechanically stronger and more able to withstand rapid changes in temperature. The glass manufacturer actually saves in production costs.

Borax is that very valuable "fourth"—that minor constituent of major importance which definitely helps you make better glass more economically.

PACIFIC COAST BORAX COMPANY

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EQUIPMENT AND SUPPLIES

NEW G-E THERMO-COUPLE

General Electric Co., Schenectady, N. Y., has developed a new radiation-type vacuum thermocouple for use wherever exceptionally high sensitivity and rapid response is needed. Enclosed in a vacuum, the thermocouple consists of a very thin filament of two different metals, blackened on one side. Radiant energy acting upon the thermocouple produces an electromotive force which is transmitted to a millivoltmeter. Possible applications include temperature measurement and control in brazing, heat-treating furnaces, glass heat-treating, infra-red drying and solar radiation. It has been found useful in controlling temperatures of rapidly moving objects on conveyors through furnaces.

CATALOGS RECEIVED

Aluminum Ladder Co., Tarentum, Pa., has just issued a new catalog describing its line of aluminum portable gravity conveyors. These conveyors are manufactured entirely of aluminum alloy with exception of the roller bearings. Two types are made—wheel and roll type and both types can be applied with adjustable legs.

George Gorton Machine Co., Racine, Wis., announces its new Accessories Catalog. This new catalog shows the prices on all items listed, including Cutter Grinders and Graduating machines. A copy of the catalog can be obtained upon application. The company also announces the establishment of an Accessories Department to handle small tools and accessories.

A. P. Green Fire Brick Co., Mexico, Mo. A folder on Greencote refractory maintenance coating. This coating can be sprayed on with the Mortar Gun or by trowel to worn or spalled sections. It is highly resistant to slag, corrosion and spalling.

Johnson Bronze Co., New Castle, Pa., Catalog L-2 "Ledaloyl Bronze Bushings." A 22 page catalog listing Ledaloyl self-lubricating bearings. In addition to listing sizes, part numbers and prices, there is a technical and application data section.

Connelly Iron Sponge and Governor Co., Chicago, Ill. Bulletin 301-B-2 "Connelly super-sensitive Back Pressure Valves." The bulletin lists several newly developed back-pressure valves. Type HR features a unique design that permits cleaning without disturbing the pipe line. Type HY is extremely sensitive and perfectly balanced for vertical mounting. These two valves and other valves are listed in the bulletin.

CATALOG & BULLETIN SERVICE

Current catalogs and manufacturers' service bulletins reviewed in this department may be obtained by writing to THE GLASS INDUSTRY.

ANNOUNCES AIR-GAS RATIOTROL

The North American Manufacturing Company of Cleveland, Ohio, has perfected a new Air-Gas Ratiotrol, a device that will be of interest to all furnace users. Ratiotrol's produce an air-gas mixture of constant proportion, making both fluids interdependent while passing through an aspirator and an atmosphere regulator respectively.

To insure successful operation of a completed installation, the aspirators possess a measure of flexibility that makes it possible to obtain some corrections for capacities and varying pipe resistances without altering the installation itself.

The control valve has an adjustable part that can be set to insure effective control of the air over the whole motor operating range together with an external by-pass to furnish air at blown pressure to an auxiliary diaphragm on the atmospheric regulator when the control motor gets to the shut off position.

The force from this diaphragm actually closes off all gas flow to the burners at this point which among other advantages, eliminates all possible overriding of temperatures at low temperature setting. The Air-Gas Ratiotrol is described in detail in the company's bulletin No. 45.

TO REPRESENT SILLIMANITE

The Charles Taylor Sons Company of Cincinnati, Ohio, announces the appointment of W. W. Miller as Chicago sales representative. Mr. Miller has had wide experience with refractory problems, having been connected with the company sales force in the Southwest for a number of years. In his new territory, he will cover the state of Wisconsin, Northern Illinois and Northern Indiana.

O. HOMMEL AWARDS

The presentation of service emblems to eleven employees who had been with the O. Hommel Company for five years or longer took place December 23, 1939 in the executive offices at Carnegie, Pa. Mr. Hommel paid homage to the older members and expressed a desire that the younger employees would follow the example of the older men and carry on the tradition that his organization be one large family.

North American's Air-Gas Ratiotrol.

HEADS PENNSALT RESEARCH

Richard L. Davies has been appointed manager of the newly established Market Research Department of the Pennsylvania Salt Manufacturing Company. He is well known in the chemical and allied industries through his sales development work, as well as for his chemical manufacturing and usage patents, and for his contributions to trade and technical publications. The new department is organized to make studies of products now manufactured or to be manufactured by the company. Mr. Davies will maintain his headquarters at the Executive Offices of the Company which are located in Philadelphia.

"VALV-AMP" ROTOR

A new type rotor construction making use of cast-aluminum rotors in the larger sizes of double-squirrel-cage motors for high-starting-torque, low-starting-current service, has been announced by the General Electric Company.

Called the "Valv-amp" rotor, it makes use of a unique shape of rotor slot and a special method of assembling rotor punching to control the flow of starting current. The "Valv-amp" allows construction of larger cast-rotor motors which inherently combine the advantages of the double-squirrel-cage motor with that of the conventional cast-rotor motor. It is claimed that the development of the "Valv-amp" rotor is the most outstanding contribution made during the past 40 years to squirrel-cage-motor design.

The De Vilbiss Company, Toledo, Ohio, will shortly resume its series of training courses for those interested in learning the technique of spray-painting, and the use and care of spray-painting equipment. Each training period lasts one week. Complete information regarding the school may be obtained from the company.

INVENTIONS AND INVENTORS

(*Continued from page 75*)

Mr. Sherts was granted another patent 2,184,876 also assigned to Pittsburgh Plate Glass Co., which discloses means of making a three layer safety glass, with the plate coated with a "tough soft" resin, which underlays a layer of a "harder" resin. The nature of these resins which are different types of poly-vinyl acetal resins, is detailed in the patent.

A machine for drawing window glass was assigned by Don R. Limbers of Clarksburg to Pittsburgh Plate Glass Co. (2,184,873). It is designed for use in connection with a lehr of the Fourcault type in which a glass sheet is drawn upward continuously and is then cut into sections. One of the objects of the invention was to remove the marks on the sheets left by the asbestos composition drawing rools. The details of the patent are not such as to allow their full discussion here, but largely concern the provision of a pair of buffing rolls, so designed and operated as to accomplish the objects of the invention.

Ormond H. Paddock of Rossford, Ohio, provides means for bending glass sheets by effecting a simultaneous movement, from opposite directions, of a mold member and a bending form, while the sheet is suspended vertically in a heating furnace. This is patent 2,182,448 assigned to Libbey-Owens-Ford Glass Co.

New Products and Uses

Logan W. Mulford of Kew Gardens, N. Y., patented (2,182,852) a roof light construction utilizing two sheets of glass with air space between for insulative purposes.

Samuel F. Cox and Percy E. Knudsen assigned to Pittsburgh Plate Glass Co., their improved means of applying tempered glass shingles to roofs and sidewalls of buildings (2,182,372).

Automobile draft shield constructions were patented by John F. Anderson of Oakland, Calif. (2,182,107) and by Guy M. Lane, who assigned his patent 2,183,684 to Motor Products Corp. of Detroit.

Closures were covered by patents 2,183,691 and 2,184,869.

Patent 2,182,480 to Clyde D. Lowry (Libbey-Owens Ford) involves a corner bar for holding together the ends of two glass sheets in the same plane, and a third sheet at a right angle to them.

Glass Blocks

John R. Loge, L. D. Soubier and L. O. Mankin assigned to Owens-Illinois, their patent 2,182,986 for a machine and method for sealing halves of glass blocks together. This is a continuous machine which takes the two halves of the block as they issue from the forming dies, brings their edges together, while heating the edges to keep them plastic, introduces a ribbon of continuously drawn glass into the channel formed by the grooved edges, and applies pressure to unite them permanently.

To overcome the stress sometimes applied to glass blocks by cement-type mortars, Samuel F. Cox (Pittsburgh Plate Glass Co., 2,182,373) proposes to replace portions of the cement with a more plastic material of the nature of caulking compound, used alternately with the cement.

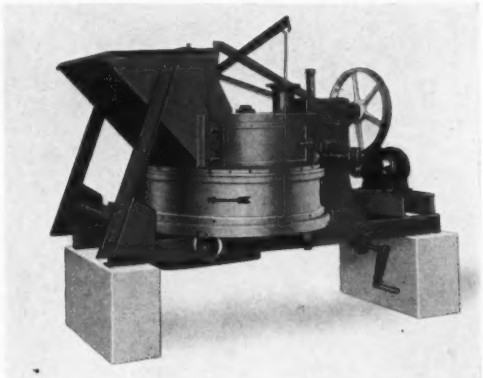
Lancaster Counter Current Rapid Batch Mixers

THE LANCASTER Mixer, designed to scientifically control all batch ingredients during the mixing operation, provides a unit of high merit for the Glass Industry.

It is fast, accurate and dependable, mixing successive batches with the same precision. Light and heavy ingredients, including crushed cullet, are distributed uniformly according to percentages, and are assured of incorporation into the mixture because the "Lancaster" closed pan construction is positively dust proof.

Quick change from one type of batch to another is afforded through easy cleaning facilities. Batch discharge is obtained by a valve mechanism conveniently located in the center of the pan for simple adaptation to local materials handling facilities.

"Lancaster" Mixers are built in a range of sizes from a laboratory type to production units capable of handling ten to twelve tons of batch per hour. Recommendations for your requirements will be submitted promptly upon request. Just drop us a line. No obligation.



EMG "Lancaster" Mixer, Stationary Hopper, Closed Pan type

LANCASTER IRON WORKS, INC.
BRICK MACHINERY DIVISION
LANCASTER, PENNA.

sodium chloride however are undesirable since they give rise to foaming of the melt and the glasses attack the molds. In some cases, however, opacity due to the precipitation of chlorides is claimed. In this respect reference may be made to M. Firth, F. W. Hodkin and W. E. S. Turner[29] who attributed opacity in potassium-lead-silica glasses into which chlorides were introduced to the formation of lead chloride. In a discussion remark Dr. S. English[30] also mentions the possibility of opacity being caused by potassium chloride.

In this connection another possibility for opacification by the formation of an insoluble lead compound may be mentioned. M. T. Welzow[31] and K. Fuwa[32] observed that tungsten gives rise to opaque glasses when incorporated in lead glasses, while in other base glasses the tungsten does not give rise to opacity. As in the above mentioned case of lead chloride here also, the tendency of lead to form undissociated insoluble compounds seems to be the cause for opacification. Another example of this property of lead is encountered in glazes for which it is known that lead oxide stabilizes chromates and uranates forming yellow and red pigments.

Opacification by Gases:

Opacification by gases is not known in glasses. It may be remembered that E. E. Enquist[7] suggested that gaseous SiF_4 may be the cause of opacity in fluorine glasses but this theory has been disproved. Opacification of enamels,[33] however, may be brought about by the development of finely distributed gas bubbles in the glass, a method which has found wide application in Europe.

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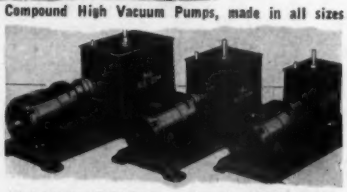

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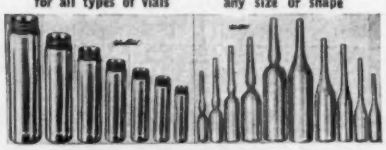

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Summary:

After a short review of the physical properties of opal glasses the chemical composition of the most important types of opal glasses was discussed. Throughout the paper an effort was made to emphasize the technical influence of batch composition rather than to discuss the scientific literature. Wherever possible conclusions were drawn from plant experience. However, in some experiments made by the authors on a large scale with fluorine opal glasses many laboratory results of former investigators could be confirmed and amplified.

Aeknowledgment

The authors wish to express their gratitude to the Dunkirk Glass Works and to Mr. Frederick Binder of Dunkirk Glass Works for having made available to Dr. Norbert Kreidl the facilities for carrying out the large scale experiments mentioned in this paper and for the invaluable assistance given to them during these experiments.

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[29]J. Soc. Glass Tech. **10** (1926) 176
[30]Discussion remark to the paper of J. W. Ryde and D. E. Yates see 9 h.
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Abstr. J. Soc. Glass Tech. **8** (1924) 8
[33]See for example J. Kreidl U.S.P. 2,102,630 Dec. 21, 1937

A joint meeting of the Art Division and of the Pittsburgh Section of the American Ceramic Society will be held February 13 in Pittsburgh. In the morning, visitors will inspect several noteworthy exhibits at the University of Pittsburgh. In the afternoon, five lectures on Ceramic subjects will be given at Mellon Institute, one of which will be by Dr. Alexander Silverman.

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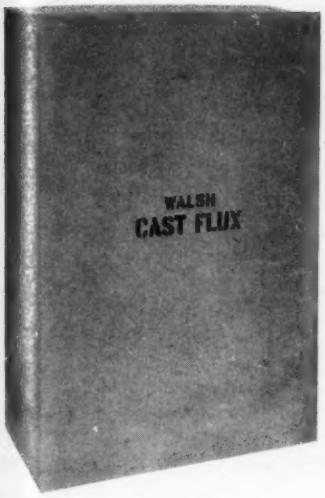

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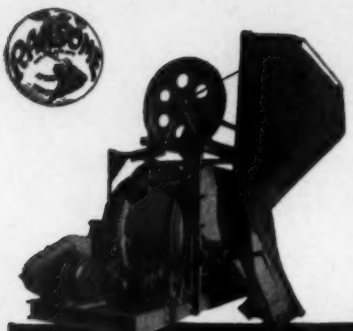

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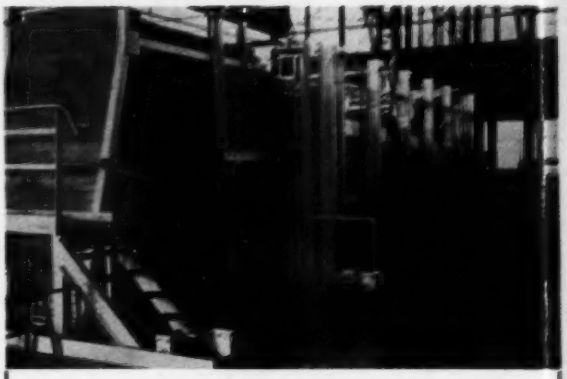

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Our files contain the records of 3,380 tests on clays and minerals. We designed and built the first and largest test furnace exclusively for testing glass house refractories. We have maintained a Mellon Institute Fellowship for 20 years . . . all for the benefit of Glass Manufacturers.

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Dustless Calcined 98/100%
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ROCKFORD, ILLINOIS
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